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Engineering News-Record

In This Issue: First of a series of articles on

Winter Construction Methods and Plant

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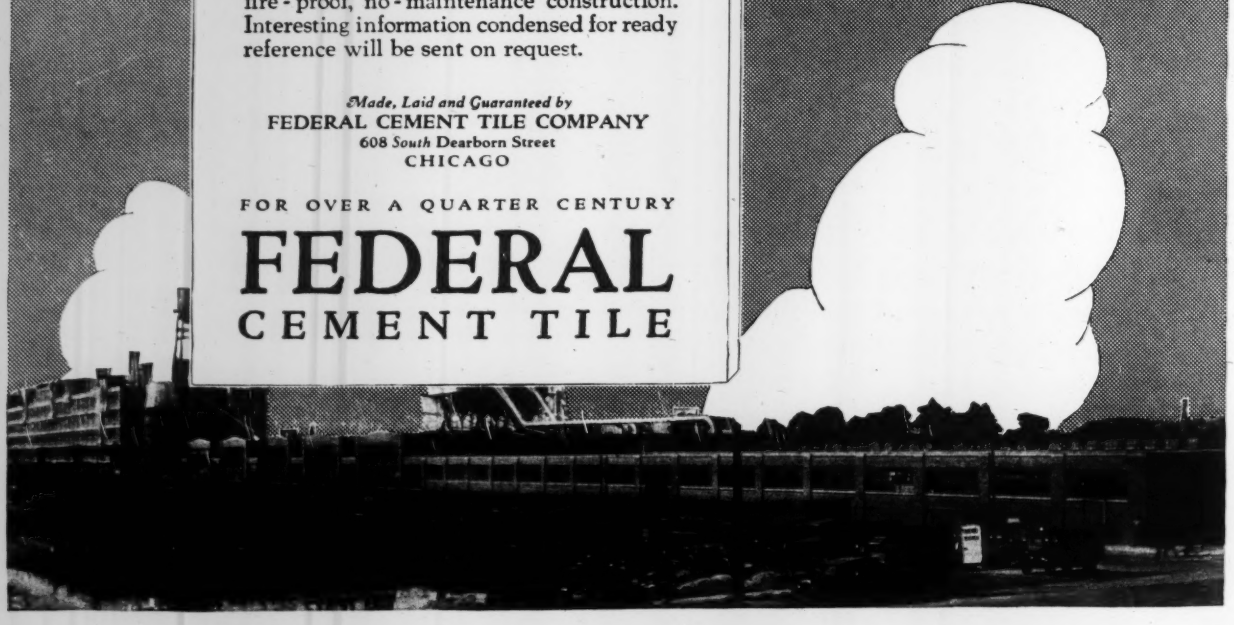

A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Two-Thirds Gone

THROUGH its first eight months business in 1927 ran true to the predictions at the first of the year. There has been no slump and there has been no such spectacular increase in the indices of prosperity as marked 1926. As predicted, the year is maintaining a fair equivalent of the 1926 figures. In general business the automobile production has fallen off, largely it is assumed because of the letdown in the Ford works in preparation for its new model. There has been some falling off in general production, particularly in iron and steel and of course in coal, due to the bituminous strike, and the railway traffic figures are down a point or two. But construction keeps up. As the regular monthly figures in the Construction News Section of this issue show, 1927 is slightly ahead of 1926, and August was far ahead of August last year. In the annual editorial review in these pages on January 13 last, it was written: "Except for the rational human expectation that all good things must some time end, there is no real indication that the era of prosperity should not continue for at least another year." That prognostication still holds good.

Seasonal Construction Declines

SEASONAL construction is declining. It is important to note this fact at the beginning in this issue of the series of articles on methods of winter construction. Briefly the index of value of building contract awards, prepared by the Federal Reserve Board, shows that in 1910 the index of building construction had a range of 66 points between the most active and the least active months. In 1922 this was reduced to 56 points and in 1926 to 42 points. True, these figures indicate only very gradual change but the thinking constructor familiar with the habits of his business expected no sudden reversal. Habit is rarely altered over night and in construction the habit of contracting in April and May for summer construction had become ingrained by generations of practice. Next to nationalizing attention on the economic waste of seasonal construction, the greatest accomplishment perhaps of the now familiar Hoover committee report was its demonstration of the fact that in building construction particularly and in engineering construction widely, habit alone was responsible for general cessation of work in cold weather. Education of the building public first to new ways of thinking and then to new practices, the report urged, was the only remedy for the situation. How far this education has progressed is indicated by the federal reserve indices. Evidently there is still a long journey to take before construction comes to full seasonal stabilization but it is on the way and the organized forces which are urging it on are still functioning. It is important that they should continue to do so and to use all the resources at their command for the work.

A Maintenance Doctrine

A NOTABLE expression of the spirit of highway maintenance in America is presented in the series of seven articles by high authorities brought to a conclusion in this issue by the inspiring contribution of the chief of the United States Bureau of Public Roads. These articles are a confession of faith which exalts engineering in public service. The greater cause for gratulation is that this faith is being justified by works. Today there are in the United States a quarter of a million miles of state-system highway all being maintained—a little of it poorly, most of it well and some of it excellently—and it is a fair guess that half as much county and township-system road ranks closely parallel in its maintenance practices and standards. Those who knew the highways in the first years of the century or even in the short twelve years ago when federal aid assumed importance can only be astounded by the change. It is not the physical facts alone, however, which command attention. Enormous significance lies in the attitude of mind toward maintenance that has been developed until now few among highway officials normally contemplate road improvement separated from the thought of upkeep. This is gratifying but that must not make for complacency. If it does no other thing the article in this issue does a notable service in calling a warning against satisfaction with the maintenance development attained. This is as yet only very partial. In particular must road officials drive into public consciousness the truth that road service is a continuing process of reconstruction and upkeep—that roads no less than railroads are ever-renewing, constantly growing structures and may no more than the railways cease to renew themselves and grow. This is the fundamental principle of the administration policy of the Bureau of Public Roads as is so well said in the article in this issue.

Advancement

DEVELOPMENT of new applications of construction equipment is a healthy symptom of construction progress. For several years such advancement has been unusually active, but some diagnosis is sometimes necessary to discover it. For instance, the following questions appear on the order blank of a company manufacturing belt conveyors: "What material is to be conveyed? Condition of material—wet, dry, hot, cold, sticky? Any chemical action on steel? On rubber? Weight per cubic foot? Capacity per hour? Receive material from bins, elevator, or crusher? Will it be fed from one point only? At which end will drive be located? Will power be motor, engine, or line shaft? In building or exposed to weather?" Hidden behind these questions is the assumption that there is a conveyor available for any possible grouping of answers. Recent applications of belt conveyors on construction

work support this assumption: A portable belt conveyor 110 ft. long has been used to place backfill over and behind a 30-ft. wall; belt conveyors have been used to distribute stone over filter beds; contractors have attached portable belt conveyors behind their trenching machines to expedite backfilling; central concreting plants have installed belt conveyors for handling cement either in bulk or in bags; and on a large water supply dam project where horses were not allowed within the reservoir site, 2½ miles of belt conveyors were used to handle 1,000,000 cu.yd. of earth beside 77,000 cu.yd. of concrete used in the core wall. Credit for these advances is about equally divided between self-reliant and progressive contractors and energetic belt conveyor manufacturers. And the above example is given only as representative of the developments that are being made in a score of other types of construction equipment.

Detour Marking

IN SOME few places it is the practice to set up at the beginning of a detour required by new road construction a map of the old and the new route. This is an excellent scheme which might be utilized more often. Such a map, roughly painted on a fairly large billboard, does not cost much compared to the cost of any construction requiring an extensive detour and it measurably adds to the comfort of those entering the detour, unless perchance the temporary route is so long and disagreeable as to make foreknowledge undesirable. Automobile tourists, for whom all road signing is intended, are becoming more and more map conscious. If they have before them at the start of a detour the way they are to take they will waste much less time looking for the sometimes elusive "detour" sign enroute and find their way back to the main road more quickly and in a much more peaceful state of mind than they will under the ordinary condition of following a blind route to an unknown destination.

More on Road Signing

PRACTICE in the placing of direction signs on roads has been so markedly improved in the last few years that it is almost captious to criticize it. Every effort is being made by our state highway departments to make the way of the traveler easy and to indicate the straight and short route which lies ahead. There is still the confusion for the stranger when the city is approached and entered, but on the open road in most places it is easier to go right than wrong. Admitting all this, it does seem sometimes that those who place the signs could profitably take along with them one who is strange to the route and to the country, and could use this stranger as a sort of indicator of where and when to mark the way. Too often it appears that the signing is done by one so familiar with the layout of the road as to have a blind spot toward the possible misconceptions of the stranger. A fork with branches of apparent equal availability will be passed unmarked because around a nearby wood the left-hand road becomes a locally well-known private entry. What the sign placer should do is to divest himself of all local knowledge and put himself in the place of a none too intelligent stranger. He must do as did the town idiot who found the jackass that was lost in the woods, he thought where he would go if he were a jackass. Roads are marked for all manner of men. Signs must be seen quickly and be readily understood. They must be placed at those places where the uncertain driver is asking himself which way to go. They are not by experts for experts. Those who place them must put themselves in the ordinary driver's place.

Protecting Tile Sewer Liners

HIGHLY septic sewage is destructive of most concrete. That is a conservative statement, but one warranted by the facts. All sewage does not destroy all concrete. In fact the evidence tends to show that properly made concrete will go far toward resisting the attack of any domestic sewage. But where the concentration is high and the detention long, the better part of judgment is gradually moving toward some kind of protection for the concrete surface. For some years Los Angeles has been lining its larger and lower concrete sewers with clay tiles and this practice has been followed more recently in other places, notably at Philadelphia. Now at Los Angeles it is found that these liners are none too secure if placed with mortar joints, so the tiles are being set in a sulphur-sand compound, as outlined in the article on p. 346. This is an experiment which will be worth watching, for it is by no means sure that this particular compound is permanent, though it probably is highly resistive. Despite years of use of concrete in sewers the whole subject of sewage attack on concrete is still in so nebulous a stage that all experimentation or experience thereon are well worth while.

Expropriation at Montreal

COINCIDENT with the Montreal typhoid epidemic this year was a series of events connected with the attempted purchase of the plant of the Montreal Water & Power Co. which occupied far more of the time of the city council and filled much more space in the local press than did the epidemic. Almost if not quite overnight, so far as most of the councilmen appear to have known, and apparently with no public knowledge before the event, the council voted to buy the privately owned water-works supplying parts of the city and important suburbs. Protests and lawsuits—injunction and libel—followed, together with a vote of the council, acceded to by the company, to have the price for the works determined by arbitration. The city took possession of the works some months ago and still operates them, although on demand of the company it voted to return them. About the same time it rescinded its vote to buy the works at the agreed price and its subsequent vote for price arbitration. Most of the protest and litigation related to the agreed price, $14,000,000, and a sale from private to private parties only a few weeks earlier on a stock transaction basis of $9,500,000. The price under the halted arbitration proceedings was not to exceed $14,000,000. With all previous action on its part rescinded, the council has quite recently voted to proceed to purchase the works by expropriation, the price to be fixed by three arbitrators. The outcome of the latest move will be interesting, both in its possible bearing on the allegation that the price agreed on by the city was exorbitant and because, unless we are mistaken, the plant in question is by far the largest one under private ownership in all Canada, nearly every water-works in the Dominion being municipally owned.

Klamath River Bridge Repairs

THERE has been widespread citation of defects in the ribs of the concrete arch bridge over the Klamath River in California. Sometimes these citations made the case appear very bad indeed, and tended to discredit the dependability of structures of this type. *Engineering News-Record* does not participate in any controversy over the relative merits of construction materials, but does recognize a responsibility for publishing the facts in matters of engineering interest. The Klamath River bridge is in a remote location where few engineers had opportunity to see it during the time the defects were exposed and the prospect of lawsuit has made interested parties cautious about giving out data. Taking all this into consideration, special effort was made to get accurate information as to the condition of the ribs in question and what has been done about it. A detailed description of the repair of these arch ribs is published elsewhere in this issue with some informative pictures of methods used in the repair work just completed.

There is no question as to the concrete having been of a very inferior quality in spots or pockets where cement and aggregate had separated at the time of pouring. Responsibility for these defects has not yet been settled but the conditions found by the board of consulting engineers retained to report on the structure were such as could not possibly have occurred if a suitable concrete mix had been properly placed and properly spaded in the forms. In other words, the defects are accounted for wholly within the field of workmanship and quite independently of design or quality of materials. Although the repair has included cutting out all accessible pockets of defective concrete and putting back good material, the major feature of the repair is the reinforced casing put on over each rib. The original plan was to make this casing 4 in. thick at the crown, which, it was believed, would make the casing so strong that the arch would never collapse, even under the worst possible conditions in the old ribs. The plan was later changed, reducing the thickness at the crown to 1 in. because the casing here is counted on wholly as a weatherproofing of the original rib. Even so, it is probable that a very considerable percentage of the stress would be carried by this casing if occasion arose, because part of the stress in the 6-in. shell at the spring line would be transmitted to the old concrete before reaching the thin crown section, and the casing as a whole would still function as a hollow arch rib carrying at the crown some stress in the material that filled the rib.

The method of repair is novel but logical and the work has every appearance of having been done effectively. That the Highway Commission has great confidence in the scheme of repair is evidenced from the fact that after the work was well under way it was deemed unnecessary, at least for the present, to supplement the encasing of the ribs with pressure grouting of the interior. The general appearance of the repaired structure is quite as good as that of the original design and, particularly if the expensive pressure grouting does not later become necessary, the Highway Commission is to be congratulated on being so cheaply out of an embarrassing situation. The moral to the case is the age old one of the imperative need for careful construction methods, followed up by strict inspection.

For President, Herbert Hoover

BY HIS cryptic memorandum a month ago, President Coolidge has, intentionally or not it is too early to say, put Herbert Hoover into the running for the Republican nomination for president. Nine months lie ahead before the nomination; nine months in which the politicians, big and little, from ward captain to senator, will be busy making medicine. Maybe the choice next June will represent the will of the people. Maybe it will, as in a June not so long since, represent the agreement of a half-dozen tired men gathered round a table in a smoke-filled hotel room. The road to the presidency is a long one and no chart for it has ever been made. But, laying aside party differences, discarding the minor issues which politics would make major, Herbert Hoover stands out today as the man best fitted to cope with the peculiar problems that confront the nation in the next decade.

Engineering more than any other human activity is engaged in the task of making this a better world in which to live. Governments, we are told in our fundamental charter, are instituted among men to secure the inalienable rights of life, liberty and the pursuit of happiness. It is too often forgotten that to the last of these the engineer really directs all his energy. For thirteen years Herbert Hoover has demonstrated that his engineering mind finds its best occupation in furthering human happiness, using that term in its proper sense. To reduce waste, to systematize business, to utilize our natural resources, to promote trade, to ameliorate drudgery, to encourage co-operation—these are the tenets of his creed as he has practiced it. They are practices readily convertible into policies of national importance. And at base they are merely expositions of the engineering mode of thought.

Mr. Hoover retains the engineering mind of his professional years. He has a passion for facts; without them he will not proceed, but having them his deductions therefrom are logical and undisturbed by expedients or personalities. He gets the answer from the problem, which is the essence of engineering, and does not prepare the problem to bring a desired answer, which is the essence of the practice of law. He has avoided the customary fault of the engineer to confine himself only to those narrow boundaries wherein lie his daily work. He has the most catholic of interests and the broadest experience in domestic and world affairs of any man today in public life. Of all engineers who have stepped out beyond the confines of their job, he seems to have lived up best to the possibilities of the profession and its ambitions. Of all the presidential possibilities he has had the best training for the responsibilities of the position.

Whether he can be nominated depends on the politicians, whose ears for the next few months are not going to rise far above the ground. Whether he can be elected depends upon the unpredictable manifestations of the spirit of fidelity to party and upon the behavior of the Democratic convention. These factors are outside the field of this journal. It is within its field to observe that the long looked for day has arrived when an engineer, professing engineering principles and practicing engineering methods, is one of the most favored potential candidates for the high office of president of the United States.

Beginning a Series of Eight Articles on

Winter Construction Methods and Plant

BY C. S. HILL
Associate Editor, Engineering News-Record

1. *Planning and Servicing Winter Construction*
2. Winter Care and Servicing of Equipment
3. Winter Excavation and Embankment Construction
4. Concrete Road Construction in Winter
5. Winter Heating Concrete Materials and Mix
6. Handling and Placing Concrete in Winter
7. Protecting Winter Placed Concrete
8. Winter Inclosure in Building Construction

Introduction

A TECHNIQUE of winter construction is being perfected. Practices have not been codified; much less have they been standardized. Constants and formula for rational planning are widely lacking. With the experience available, however, constructors familiar with winter construction approach it with entire confidence and any constructor can gather the information which will warrant him in undertaking construction in cold weather. The present series of articles is an effort to assemble this experience in such shape that it can be readily consulted and made use of. The need of such an undertaking is conspicuous.

Every season furnishes its examples of concrete failures due to ignorance of safe cold weather construction practice. Only when these failures amount to structural disasters does the construction world take note of them. The countless occasions when only surface spalling or the rupture or weakening of a detail are the result go by with only the notice of the constructor who patches up the fault. Freezing is a real hazard in construction and particularly in concrete construction. It may readily be guarded against, as the articles describe; but it cannot be ignored and the articles will have failed of their purpose if they do not drive home the conviction to every reader that the constructor assumes an extra risk when he undertakes winter concreting. Let him take the risk with confidence but with the proved defensive measures that experience furnishes him.

Since 1924 when the report of what is commonly known as the Hoover committee on seasonal operation was made public there has been increased interest in cutting down this item of industrial waste and an appreciable lengthening of the annual construction period. All-the-year operation is an accepted doctrine of the construction business. Contractors' associations, building trades employers' associations, associations of construction materials and equipment producers, individual contractors and manufacturers are all doing promotional work. Except that effort may not be slackened, this phase of the movement for winter construction may be accepted as formulated. The same progress has not been made in formulating a technique of winter construction. The call for such a labor is being voiced. In its report for 1926, the Committee on Construction Development of the Associated General Contractors said:

"In the matter of winter construction, which the association has promoted consistently, it is noted that seasonal fluctuations in certain lines of construction are beginning to decline. It is believed important, however, to call attention to the fact that while winter operations have greatly increased, there has not been any extensive exchange of ideas on methods of winter construction. The pouring of concrete in extremely cold weather presents numerous dangers to those who are unfamiliar with proper methods. Failures are likely to occur, or the methods used, if safe, may be inefficient and costly. It is therefore suggested that the association give thought to methods of winter construction and establish contact with the engineering societies to develop the subject."

The committee has not exaggerated the importance of the task or the imminent need of its accomplishment. We believe the articles of this series make a beginning. They lack lamentably in constants and formula for rational planning; in this respect they only reflect actual practice and emphasize where fundamental data are wanted. They are, however, as said, a beginning. They also present more complete information on their subject than is elsewhere available in one place. The sources of this information have been many. For the main sources it has been possible to give some credit in the text but there are scores of others for which only blanket credit can be offered. Many of the operations have been personally visited and observed. All the information is from authoritative sources. What does the round-up give us?

1. The knowledge that most kinds of construction can be carried on under the most severe winter conditions with means readily available to the contractor and with entire safety to the structure.

2. A summary of the principles and practices which have been successful in winter construction and which together constitute virtually a manual of practical methods and equipment.

3. A clear conception of the deficiencies in constants and formulas for rationally planning winter work and therefrom a plainly charted course for experiment and study.

1—Planning and Servicing Winter Construction

MATERIALS, supplies and certain servicing processes are common to all construction. The effect on them of cold is, then, the first consideration in winter work. This effect is various, depending upon the nature of the material or process, upon snowfall and storm, and in particular upon the moisture conditions. Cold makes virtually all materials and supplies more intractable to use, it makes some impossible of use until frost is removed, and it prevents the proper functioning of and may do integral damage to others. Some servicing processes are hindered by cold and for others frost and snow may actually improve conditions. It is therefore impracticable to lay down any universal rule of winter procedure with respect to materials handling and servicing processes. This necessitates separate consideration of each material or process or of each class of similar materials or processes; in brief, a separate winter construction plan for each operation. This is the first axiom of successful construction in cold weather.

The Planning Approach—Primarily in winter construction there is need to develop a "winter complex." Cold weather produces certain conditions which warm weather does not. Whether summer conditions are more or less harmful or helpful is not the question. The winter conditions are different and are distinctly positive and characteristic. They have to be met by similarly different characteristics and positive winter construction planning. In brief, provisions for meeting winter conditions are not something to be grafted onto a construction plan. They must be contemplated in the premises and through every procedure of working out the plan. It is in this conception only that planning winter work emerges into the class of considered procedures of construction. There is nothing incidental in the effects of frost and snow on construction materials and servicing processes; they are in varying degrees substantial and ever-present influences in devising working plant and methods. They must be considered always in relation to this aspect.

Construction Materials—Ice formation is about the only damaging effect of cold on the major construction materials except concrete. Also, their resistance, except concrete, to ice formation is virtually nil. Contained or entrapped water by freezing may affect the usability of brick, tile, stone, steel, timber, crushed rock, sand and gravel and to some extent on some of them may act disruptively, but ordinarily it does no damage which is not repaired by thawing. Concrete offers a positive resistance to frost action and suffers at least delayed attainment of strength and maybe permanent structural injury by freezing. Its consideration as a winter building material is paramount, and is extended in Articles 6 to 8.

Winter handling and care of construction materials ordinarily does not contemplate shelter. Their bulk makes inclosed storage expensive and as generally ice formation does them no hurt it is cheaper to store them unsheltered and thaw the ice away as they are requisitioned for use. This does not mean that careless location of stock piles where snow and ice can accumulate is permissible. Indeed, every reasonable care should be taken to choose dry and sheltered storage places. Cement is the exception; cold does it no harm, but it must be housed against moisture, and for this the requirements are no different for winter than for any other time. Except cement, then, winter handling of construction materials involves no task due to cold except the process (generally thawing) of preparing them for use.

Lubricants—Special lubricants and special handling of lubricants are required for cold weather equipment operations. Neglecting technicalities and fine qualifications, the suitability of a lubricant for cold weather use is determined by (1) its viscosity and (2) its pour point at which the oil will pour or flow when chilled. Not only must oils and greases be of such characteristics as to be readily handled, but also they must be capable of flowing to the innermost surfaces of the wearing elements under the action of gravity or the available pressure. Simply because it may be practicable to handle such lubricants in a steamheated building it must not be neglected to investigate their viscosity and pour point at zero or under whatever probable outdoor temperature they may be used. In general, however, the practical constructor had better call in the lubricating expert when it comes to specifying and testing cold weather oils. The accompanying table gives the characteristics of lubricants for cold weather advised by A. F. Brewer, mechanical engineer, The Texas Co.

Specific directions for winter lubrication are given in Article 2. It remains to be stated, however, that in winter work it will be found economical always to provide a warm storage room for oils and greases. Machinery chilled by standing out of doors puts enough handicap on the action of lubricants without also bringing them chilled to the work.

FIG. 1—CAMP BUILDINGS ON A WINTER OPERATION

Explosives—Many of the modern high explosives are low freezing; these should always be selected for winter blasting. The temperatures at which these explosives freeze are indefinite. They vary with conditions. The makers assert that: "Low-freezing explosives will not freeze under ordinary exposure to such atmospheric temperatures as are normally met with in this country." It is recorded where "non-freezing" dynamites have frozen at zero, and again where they have not frozen at 40 deg. below zero. The way of intelligence for the constructor is to guard his explosives against freezing conditions, and methods of doing this and of thawing explosives which are frozen are referred to in Article 3.

Camp Servicing of Labor—Extra camp service is required in winter. There has to be heat and particularly there has to be warmth and plenty of hot water for bathing and clothes washing. If these duties are not made comfortable they will be neglected and personal

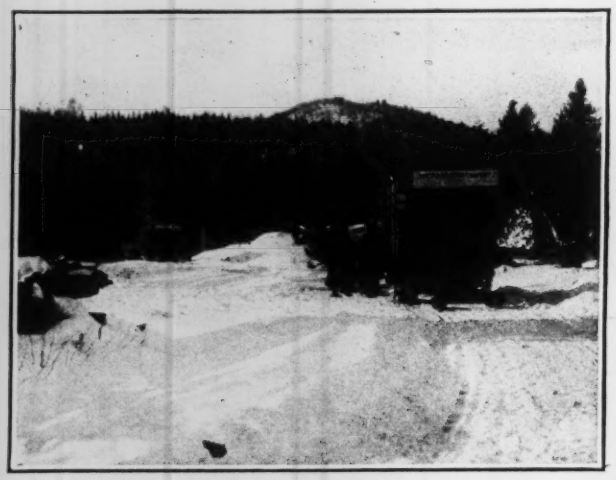


FIG. 2—TRACTOR PACKED SNOW ROAD

hygiene will suffer with increased danger of infection to cuts and punctures and a lowered resistance to disease. Lighting, too, has to be better. There is more darkness in winter, the men are in the house more, they take their recreation inside. And here, let it be noted, more facilities for recreation are desirable. Irritableness develops rapidly where men are cooped in without means of diversion. The construction camp is often pretty bleak, Fig. 1. A recreation hall, a motion picture projector, a radio outfit are very profitable pieces of equipment for any winter construction camp.

Hygiene and sanitation have been spoken of; they should extend into the housekeeping particularly. Ventilation and airing have to be better looked after in winter; the men who open their windows for comfort in summer will in winter close them for the same purpose. Plenty of blankets will help much in keeping a well-aired bunk house in winter. Water supply is all-important, and also calls for more cold-weather precautions than any other camp servicing. Means of cold weather water supply for construction operations are described in Article 2.

Winter conditions provide different kinds of camp hospital cases than do summer conditions, but the service required is not especially more exacting or difficult. In particular, however, general sanitation cannot be slacked off in winter. The fact that frost seals up the offensiveness of filth and decay may permit some delay

TABLE I—LUBRICATION RECOMMENDATIONS FOR CONSTRUCTION MACHINERY

Part to be Lubricated	Viscosity, Seconds Saybolt — Summer	Winter	Pour Test Range for Winter Service
Gears—Exposed or merely guarded	2,000 at 210°	1,000 at 210°	
Gears — Enclosed, where bath lubrication is possible	1,000 at 210	115 to 200 at 210	15° F. or lower
Wire rope	1,000 at 210	500–600 at 210	
Chains—Roller type usually exposed	1,000 at 210	500–600 at 210	
Chains—Silent or link type			
Exposed	115–120 at 210	70– 80 at 210	10° F. or lower
Enclosed	70– 80 at 210	55– 60 at 210	0° F. if possible
Steam cylinders	130–150 at 210	120–130 at 210	As low as possible
Link pins and rollers of caterpillar tractors	200 at 210	115 at 210	15° F. or lower
Internal combustion engines	See recommendations of builders and oil companies, according to type and size of engines and fuel used		0° F. if possible
Electric motors			
Ring oiled bearings	300 at 100	180–200 at 100	0° F.
Ball and roller bearings			
Oil lubricated	150–200 at 100	100 at 100	0° F.
Grease lubricated	A grease of light or medium consistency		
Journal boxes	100 at 210	60 at 210	15° F. or lower
Miscellaneous other bearings			
Oil lubricated	300–500 at 100	200–300 at 100	0° F.
Grease lubricated	Medium cup grease	Light cup grease	

in, but does not lessen the necessity of, the sanitary disposal of garbage, sewage and other wastes.

Job Servicing of Labor—Besides the camp servicing of workmen which has been indicated, there has to be in winter extra or different job servicing. The larger portion of this has to do with providing safe accessibility to working operations about the job, and this is developed in the succeeding section. Another portion is job shelter.

Camp housing is not the only shelter which winter conditions make desirable. Workmen can be protected in many operations by huts or wind-breaks, and the protection usually pays a profit of greater efficiency. It is not meant that every man shall lug about an oil stove and a pup tent; common sense must be exercised. But the writer has seen jackhammer drill men working inside small portable cone-shaped cove tents and a group of shovelers in the lee of a canvas wind break, and footage and yardage were added to the day's performance as a consequence. Open fires, or better, a lean-to and stove where the men can go occasionally to warm their hands, will help keep labor on the job. In speaking of labor efficiency in cold weather, A. M. Bouillon, with experience on many winter operations, says:

> On quiet days with temperatures not lower than about 5 deg. below zero, the average production output per man on outside work is not decreased, but is practically at its highest, the same as in the cool days following the first frost of the late fall, for the men are active and work steadily, the slight nip of the cold proving an incentive to exercise, so that they unconsciously accomplish more than the usual summer average. However, when the weather is so cold as to compel men to hamper their movements with heavy clothes, such as happens when the temperature reaches about 20 deg. below zero and also *when there is a wind at any temperature below freezing*, there is a perceptible slackening in the work of the men in exposed places, but this does not affect men working under shelter.

Practices in the larger tasks of job shelter are described in the succeeding articles; they have been carefully and quite adequately developed. It is the minor opportunities for shelter and particularly portable shelter which are in mind here and which have been neglected.

Transportation Service—Accessibility is influenced by winter conditions in a large way only in case of operations remote from railways or highways sufficient for heavy hauling. In these operations two ways, (a) spur railways

and (b) tractor roads, are commonly employed to get from rail head to construction site. In case of spur railways the usual railway methods and equipment for winter operation are employed. An example is the railway built to the Isle Maligne power plant on the Saguenay in the Lake St. John region of Quebec. Almost 30 miles of standard-gage railway were built here to serve the scattered operations of which 11 miles were in the main branch track from the Canadian National Rys. This 30-mile system was, like any regularly operated railway, equipped and organized for winter maintenance and operation, with snow plow, track gangs, and special gangs as the necessities demanded.

In case of tractor roads, there are more special considerations. Here there is no heritage of proved practices to draw upon as is the case with railways. But the case is different in another respect. In general, winter, particularly if there is a good depth of permanent snow, improves road conditions. The road is over existing country wagon roads or forest trails; most often it is new road entirely or in part; is temporary, and is

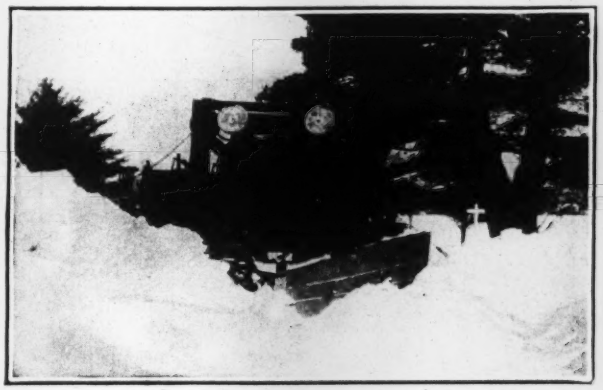


FIG. 3—TRACTOR CLEARING DRIFTED ROAD

kept down to the meagerest structure possible. It is these roads that frost and snow solidify and surface and turn into almost ideal tractor ways. Their maintenance, once the snow falls deep, comes from the tamping of the wide crawler treads and the surface packs harder and smoother, Fig. 2, as the tractor service increases. The tractor too is a good snow fighter, Fig. 3, when the need arises. Winter tractor haulage, then, is chiefly a problem of cold weather tractor operating methods which are discussed in the succeeding Article 2 on winter care and operation of equipment.

As an outstanding example of winter tractor haulage, reference is made to the 30-mile haul (60-mile round trip) to the Baskatong reservoir dams for the Gatineau River power development in northern Quebec. The diagram, Fig. 4, shows the hauling record during one winter and summer; note the uninterrupted winter schedule, the effect of the spring break-up, and the uninterrupted dry-weather summer schedule. Winter haulage was as fast as summer haulage at its fastest. Indeed, the results were better in winter. Once steady cold had set in and snow had fallen, road maintenance was a negligible task; the traffic kept the road packed and surfaced. The winter task was equipment care and operation.

The hauling units, ten of them, were tractors with rear caterpillars and forward sled runners and load-carrying (8-ton) bodies. A tractor and a trailer made up a "train." The trailers were standard logging sleds. The operating schedule with two operators was a round trip (60 miles) in 16 hours, then a lay-off for the crew of 16 hours. Three trailers were provided for each tractor, allowing one at rail head being loaded, one on the road, and one at the job being unloaded. The tractors themselves on each return to rail head were run into the garage and carefully gone over, oiled, given fuel and generally hostled, given body loads, and sent out with a loaded trailer. Generally a tractor made nine trips in seven days. The average load during the period covered by the chart Fig. 4 was 18½ tons; the average summer load, with forward truck wheels on the tractors and wheel trailers, was 11 tons. The maximum winter load was 38 tons.

The schedule described was the winter schedule when hauling conditions were the best. The ground was hard with frost, the snow packed solid under the caterpillars, and the roads improved with travel. The tractors made better speed, suffered fewer breakdowns and required fewer repairs. The logging sleighs worked finely as trailers. Naturally, some cold weather precautions had to be taken. Kerosene was used in the radiators, and the tractors when idle for any time were kept in a heated garage; left outdoors, the caterpillars and radiators froze. In brief, the cold weather precautions were simply those which every automobile owner knows and practices.

Transportation service includes consideration of intra-job movement. The means, standard and narrow-gage service railways, tractors, truck and wagon roads, trestles, walks, stairs and ladders, are no different for winter than

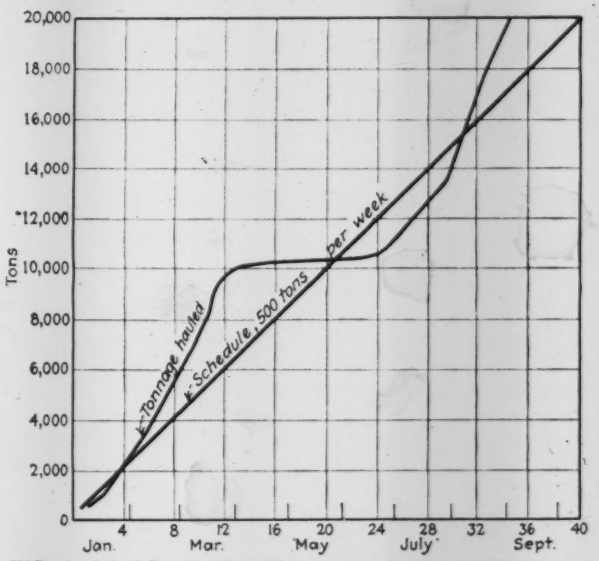


FIG. 4—CHART OF TRACTOR HAULAGE PERFORMANCE ON SNOW ROADS

for summer. The special winter task is to remove snow and ice obstacles and hazards. Shoveling off snow, picking or thawing away ice, sanding walks and stairs, installing hand rails, are the simple operations. They are imperative and they require men and money.

Fire Protection—In winter there is less danger from spreading leaf and brush fires, and all litter, lumber stock, falseworks and forms are less inflammable than in summer. There are, however, in materials heating furnaces, boiler fires, salamanders and stoves more foci for the start of flame. The men too will build open fires for hand warming and other personal uses. Winter puts

a handicap on the ordinary means of fighting fire. Pipe lines freeze and water in barrels and pails becomes ice unless all are guarded against frost. Prevention is not easy at costs which temporary water supply for fire fighting can afford. In general head cannot be kept constantly on fire mains; they have to be kept dry and put under head only when the call comes for use. So too the water barrels and buckets have to be constantly thawed out and freshly filled. Fire protection then, like many other winter servicing tasks, is not a problem of special installations so much as it is the development of a meticulous procedure in keeping frost away from the normal installations.

In building work one of the fire hazards is canvas inclosures heated by salamanders. Canvas is inflammable and waterproofed canvas is particularly so. There appears to have been little success in fireproofing canvas. Most fireproofing application is easily soluble in water and exposure of covers and curtains to the weather soon puts any fireproofing out of commission. Again it causes mildew and rapid deterioration of the cloth. The best fire protection of canvas enclosures is to see that the curtains and covers are so well lashed that they cannot fall or flap into the salamander fires. Then provide handy water barrels and buckets and a good watchman.

Power Service—Steam and gasoline equipment call for no servicing except fuel supply. Compressed air and electric equipment require power transmission lines. In the case of electric power, there are no different requirements in winter than in other seasons; the same rules hold good in respect to armoring, insulation and waterproofing. Air lines, however, call for particular care in winter. With the loss in the air line of the heat of compression, compressed air loses volume and gives up some of its moisture. Reheating, always desirable if the lines are long, is especially necessary in winter and freezing has to be guarded against. Generally speaking, freezing in receivers and pipe lines is all that has to be guarded against, since air drills and modern pneumatic tools nowadays are invariably non-freezing. With air-operated engines and hoists, however, freezing at the machine may have to be guarded against. In air lines, traps and drain cocks at low points are needed. Automatic drop oilers set in the pipe line and feeding in turpentine or denatured alcohol will retard freezing. For reheating, manufacturers make special stoves. A coil in the pipe line with a wood fire inside is effective. In brief, air transmission in winter calls only for simple and easily secured limiting means of protection, but they are important.

Street and Refuse Sanitation Costs

Sanitation costs, as they are called, of nine large cities are given in the 1926 annual report of the Department of Street, Sewer and Catch Basin Cleaning of the City of Cincinnati. These figures show the following total costs for street and sewer cleaning, ash and rubbish collection, per capita, to be: Cleveland, $0.838; Cincinnati, $0.996; Baltimore, $1.27; Washington, $1.285; Columbus $1.31; Milwaukee, $1.617; Chicago, $1,679; Philadelphia, $2.36; Detroit, $2.955. The 1926 costs per cubic yard of ash and street sweepings collection in Cincinnati, which was somewhat higher than in 1925, owing to an increase in the total payroll, was:

	Wagons	Tractors	Trucks
Ash collection	$0.847	$0.74	$0.64
Street sweepings	0.933	0.84	0.539

Repairing Concrete Arch Ribs in Klamath River Bridge

Reinforced Gunite Casing 6 in. Thick Put on After Defective Spots Were Filled In by Patching and Grouting

REPAIRS consisting of patching defective places in the concrete arch ribs and then completely encasing the ribs in reinforced gunite have been under way for several months on the highway bridge across Klamath River in northern California. The bridge is a new structure, completed only a year ago. It is located on the main coast route about 70 miles north of Eureka and consists principally of five arch spans of the open-spandrel type, each about 205½ ft. long, with a rise of 30 ft. 10 in. In a general way the repairs follow recommendations made by three consulting engineers appointed by the state highway engineer in July of last year to advise on means of strengthening the arch ribs. The deficiencies in the arches were ascribed by these

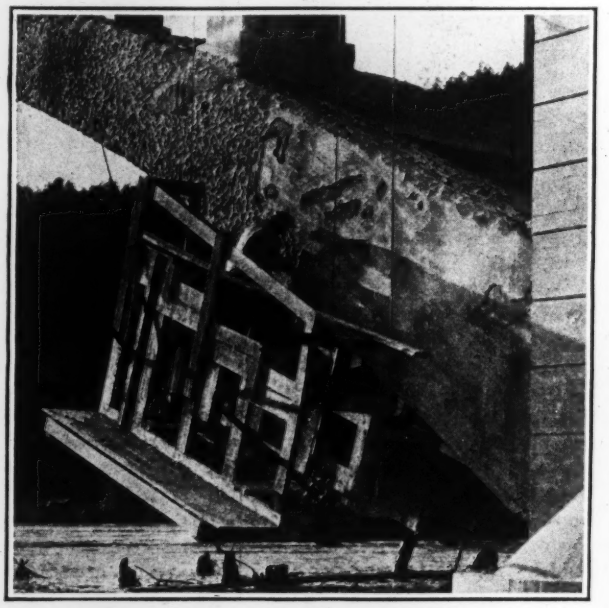


FIG. 1—CHIPPING AND PATCHING RIB SURFACE
Sand and gravel pockets were cleaned out and filled with gunite. Entire rib surface chipped to insure bond.

engineers chiefly to rock and sand pockets, due to inadequate spading in the forms and to other defects in construction. A review of their report appeared in *Engineering News-Record*, Dec. 30, 1926, p. 1080.

In the main, the repair work was done in four successive operations. First, pockets of bad concrete accessible from the outside were thoroughly cleaned out, and the holes were then filled with gunite. Next, the interior of the ribs in the worst sections was grouted under pressure, using the holes previously drilled in the ribs for taking core samples and also additional holes drilled specially for the grouting. The corners of the arch ribs were then rounded off, and the four sides were thoroughly roughened by chipping with air hammers to assure a good bond between gunite and original concrete. Finally, a reinforcing system consisting of ½-in. bars

and wire mesh was placed entirely around the ribs, and gunite was applied in several successive layers, the total thickness of the casing so placed ranging from 6 in. at the spring line to 1 in. at the crown.

The work was begun early in December, 1926, but the actual placing of the gunite casing on the ribs did not start until about April, 1927. With a single cement gun on the job about three weeks were required to encase the ribs of one span (span 5). A second gunite outfit was then started and a better plan of operation was developed, with the result that all repair work was finished by the end of June. Work was done from a swinging scaffold slung from a jumbo arranged to move along the bridge as the work progressed, Fig. 1. When the scaffold was to be transferred to another span, a motor boat on the river moved a scow into position, and the scaffold was deposited upon it and towed to the new position and connected to the supporting ropes.

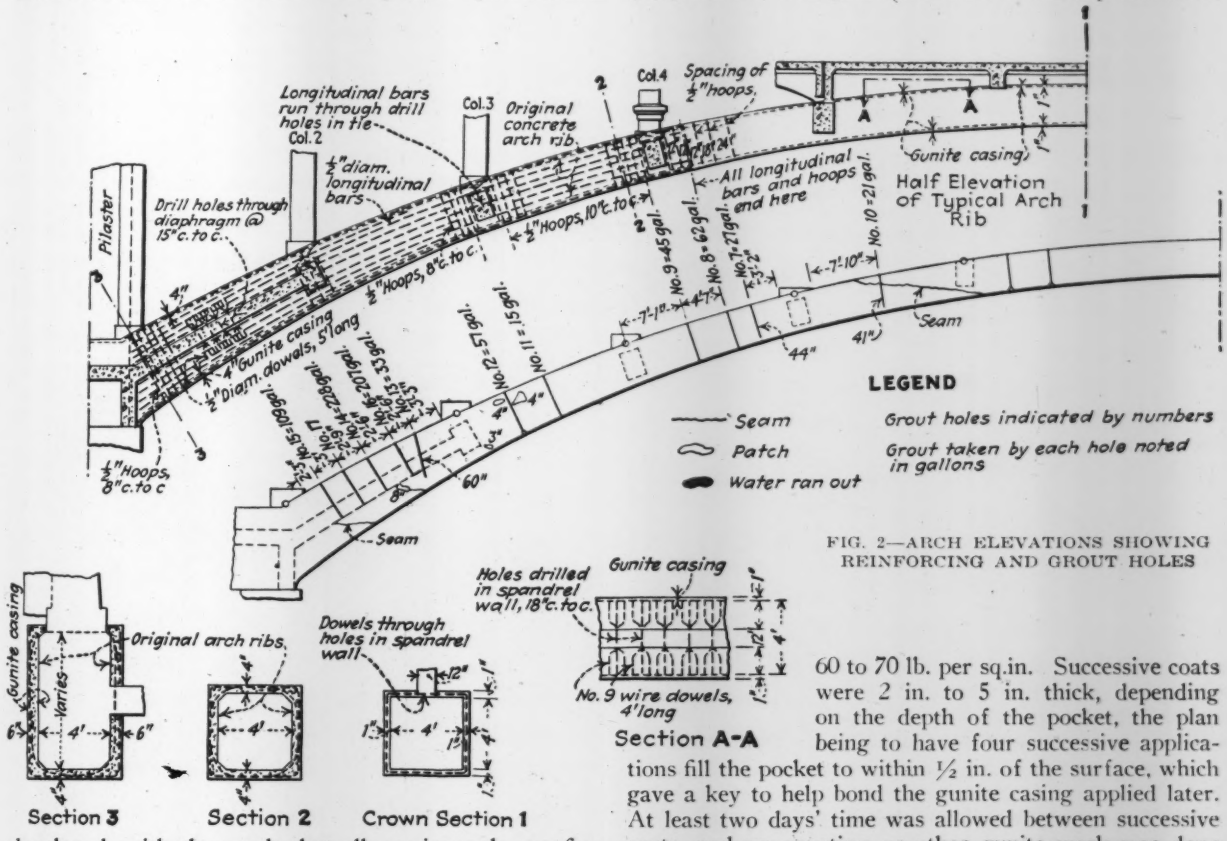


FIG. 2—ARCH ELEVATIONS SHOWING REINFORCING AND GROUT HOLES

Air drills were used for cleaning out the pockets of defective material in the rib concrete. These pockets ranged from 2 to 5 ft. in length, ½ to 2 ft. in width, and 5 to 24 in. in depth. When all faulty material had been removed from a pocket and the surface of the sound concrete roughened for bond, the exposed steel was thoroughly sandblasted. The operation of filling the pockets with gunite was commenced at one end of a rib, and the scaffold moved along the rib as the work progressed. The gunite was shot in under pressures of 60 to 70 lb. per sq.in. Successive coats were 2 in. to 5 in. thick, depending on the depth of the pocket, the plan being to have four successive applications fill the pocket to within ½ in. of the surface, which gave a key to help bond the gunite casing applied later. At least two days' time was allowed between successive coats, and no grouting or other gunite work was done near a patch for 10 days after placing the last layer.

The original plans for the gunite coating called for the use of wood headers in laying off sections of the work that were to be done successively. The contractor, however, preferred to "feather off" the edges of each layer in order to avoid trapping rebound.

In preparing for grouting, 1½-in. holes were drilled in the ribs from the top to within 1 ft. of the bottom. The spacing of holes ranged from 30 in. in the worst sections to 8 ft. toward the crown of the arch, where the conditions were generally better because the forms had been more accessible, Fig. 2. Around the top of each grout hole the concrete was cut away for a depth of 6 in. in a circle 9 in. in diameter, to provide an anchorage for the grout pipe. Into this hole was set a 1½-in. pipe, extending 3 in. above the rib, so that it could be attached by a coupling to the grout hose, Fig. 3. This pipe was fitted with an extra heavy coupling at a level below the top of the arch rib, thus providing a shoulder on which uplift could be carried, and heavy grout was poured over the coupling and around the pipe, flush with the top of the rim. The grout, in turn, was anchored down by a ½-in. plate 12 in. square with a hole in the center.

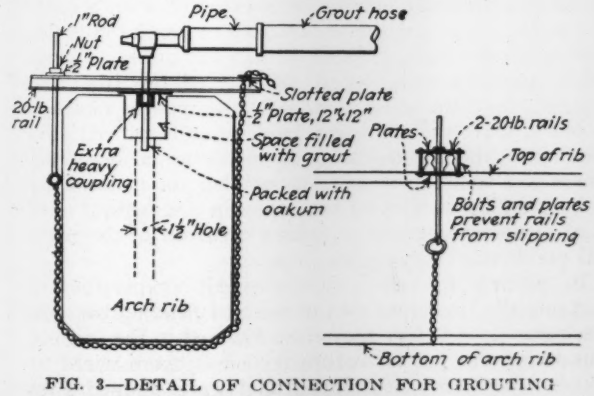


FIG. 3—DETAIL OF CONNECTION FOR GROUTING

held to the arch rib by a yoke of rails and chain passing entirely around the rib. A 2-in. hose from the grout gun was connected through a reducing coupling to the grout pipe. Two outfiits were alternated, one connected to the hose and used while the other was being moved.

The grout consisted of 2 parts of sand that would pass a No. 20 sieve and one part of cement, mixed dry. To 4 gal. of this mix was added 1½ gal. of water. Before putting grout into the gun, air pressure was applied on all holes for 15 to 20 min., starting with 100 lb. per sq.in. and increasing to 250 lb. By this air-pressure treatment, water that had been held in air pockets within the ribs was frequently blown out, sometimes appearing 12 ft. away, bubbling out of the rib and around the base of the columns or even in the adjoining tie beams.

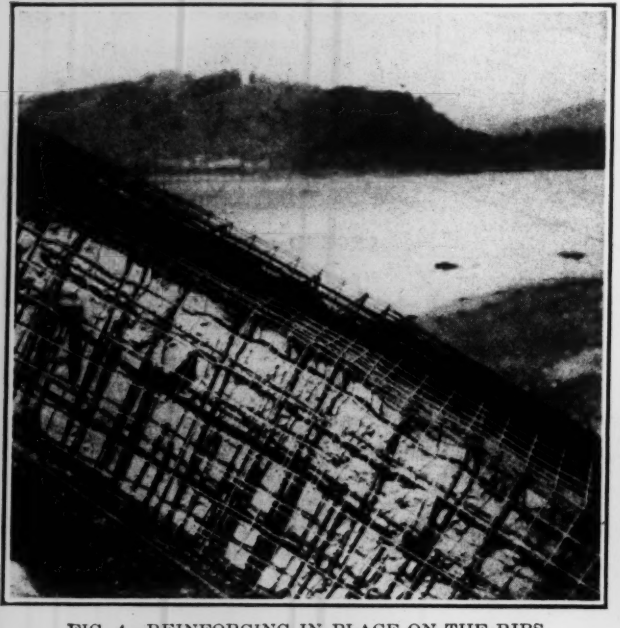


FIG. 4—REINFORCING IN PLACE ON THE RIBS

When the grout was first applied to a new hole the pressure was kept down to 100 or 150 lb. per sq.in., as greater pressure would sometimes blow the grout entirely out of the rib through openings on the sides, bottom or top. After 6 to 12 gal. of grout had been placed at low pressures, the pressure could be increased to 250 lb. per sq.in. without loss of grout. Generally speaking, a hole would take from 20 to 70 or 80 gal. of grout; the maximum in one hole was about 200 gal. There was no easy way to tell when the grout had all gone into the rib. In the early part of the work this was determined by opening a valve on the outer end of a tee where the grout hose was attached, an unsatisfactory method. Later H. E. Fearnall, an assistant engineer of the State Highway Commission, devised and assembled an apparatus that would indicate when the pocket had been filled with grout. Before using this appliance not over 30 to 40 gal. of grout was placed in one day but afterwards the rate was increased to 60 to 85 gal. per day. This device consisted of a ¼-in. case-hardened steel bolt sharpened to a needle point and tapped into the grout pipe. This bolt was connected through a 45-volt battery, a pair of ear phones and an electric lamp as series resistance, to the pipe coupling. Conditions in the grout pipe directly affected the flow of current in

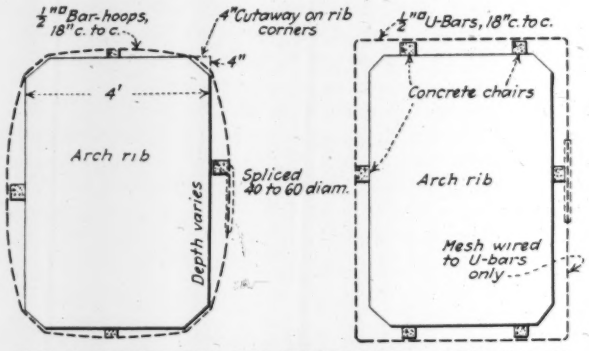


FIG. 5—U-BARS AND BAR HOOPS WERE ALTERNATED

the circuit thus established. When the grout was moving, the sound in the head phones was quite distinct from that heard when air was passing. When the hole was filled, of course, neither air nor grout could be heard.

When stopping grouting for the day at an unfinished grout hole, the final operation was to force air into the hole to drive the grout away from the pipe and thus prevent hardening that would give interference next day.

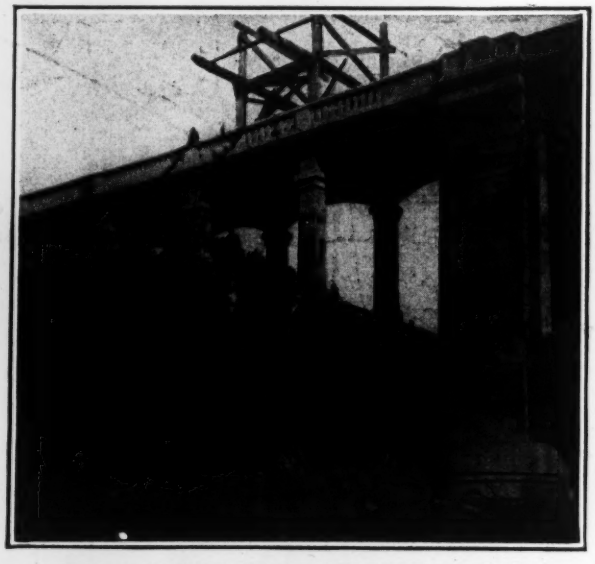


FIG. 6—GUNITE CREWS AT WORK ON RIBS
The coating was applied in successive layers; maximum thickness, 6 in. Wires indicated surface of rough finish and pegs marked final finish.

As originally planned, the repair work was to include grouting all the ribs at regular intervals, but on account of the high cost and the uncertainty of results only one span was completely grouted all the way across. In the other spans only the worst sections of the ribs were grouted, the idea being that if it later proves desirable to put in more grout this can be done quite as well after completing the gunite casing as in the initial operation. There was some question as to whether the material put in by grouting could take any stress in a structural sense until settlement or partial failure occurred in the material previously carrying the load.

In placing the steel reinforcement preparatory to encasing the ribs, most of the work of bending bars and mesh was done before they were lowered to the scaffold. The bars were put on before the mesh, were wired together where they overlapped, and were wedged away

from the ribs the desired amount with concrete blocks. At intervals of about 8 ft. on the top and sides the rib concrete was dug away to expose one of the bars in the original reinforcing system and the new bars were then wired to this old reinforcement. Finally the 4x4-in. No. 6 wire mesh, cut and bent into two right-angle sections, was put on and wired to the steel bars.

The gunite casing varied in thickness from 6 in. on sides and 4 in. on top and bottom of the ribs at the spring line to 1 in. on all four sides at the crown. The crown sections of the ribs were not believed to be in need of reinforcement because here the ribs were strengthened by being tied into the floor system. The 1-in. gunite covering was placed in the crown sections solely for waterproofing and protection of the reinforcing steel. Particular care was taken to make the covering impervious because the bridge is within two miles of the ocean and protection of the steel from corrosion due to salt fogs was considered very important.

The reinforcing bars are all ½ in. in diameter. For the first two panels from the spring line the spacing of the bars was 8 in., beyond which it was gradually increased to 24 in. in the fourth panel. In the remaining sections only the wire mesh was used as reinforcement. The original provision was for a 5-in. spacing of the bars, but this spacing, combined with the wire mesh, was found too close for satisfactory placing of the gunite and the 8-in. spacing was substituted.

The gunite casing work was started at the spring line and brought to full thickness half way between spandrel columns 2 and 3 at each end of the rib and, after this part had set, carried to column 4 and over the crown.

In putting on the gunite coating the first step was to build up to the outer side of the reinforcing. This was done in three successive layers to avoid danger of sag and loosening of the gunite from the rib which it was feared would result if the full weight was put on the green mix. Comparative tests showed that better results were obtained by using sand with a moisture content of 4¼ per cent before the cement and diatomaceous earth were added. The ingredients were mixed three to four times and then passed through a ⅜-in. screen before being placed in the gun. Diatomaceous earth 2½ per cent by weight was used in grout for cavities and gunite casing. Addition of this flux was said to reduce the rebound (approximately 10 per cent) and in the casing mix to lessen somewhat the difficulty of effective placement on the under side of the arch ribs. This part of the work gave considerable trouble if the mix was too thick.

The depth of the gunite applications was gaged with the aid of pegs driven into holes in the arch rib before guniting commenced. These pegs were set with their ends in the plane to be reached by the finish coat. After the reinforcing had been covered with gunite, wires were stretched between the pegs ½ in. from the peg ends and these wires indicated to the crew the surface to which the first finish layer should be carried. This rough finish was rodded off to the wire markers to give the arch ribs plane surfaces on all four sides.

Commenting on the condition of the ribs immediately after placing of the gunite coating, A. S. Kennedy, resident engineer for the State Highway Commission, stated, "There have been no shrinkage cracks in the gunite casing on the arch ribs, although some occurred in the gunite patches placed in the holes in the arch rib of span 5. These patches were 1 ft. in diameter by 6 to 12 in. deep and the cracks were near their centers. Of the 75 patches in the ribs of this span only 4 cracked and on cutting into these it was found that the cracks extended only through the outer layer. Patches in other spans had no cracks.

"The cracks in the patches were caused by insufficient wetting during curing. Up to the time these patches were made there had been continual rain and fog so not much wetting had been required. With a change to dry, windy weather that followed the completion of these patches, more moisture was required than was supplied.

"No shrinkage cracks were found around the edges of any gunite patches, and during the operation of grouting the interiors of the arch ribs no air bubbles appeared at the edges although grout and air were being introduced under pressures of 250 lb. per sq.in. This indicated perfect bond between the old concrete and the gunite because air escaped all over the surfaces of the ribs including points in some cases within an inch of the patches."

The repairing of the arch ribs was done by the California Air Construction Co. under contract with the California Highway Commission, the total cost of this work being about $60,000. A sum sufficient to cover this cost has been withheld from payments made under the general contract for the construction of the bridge awaiting the state's final acceptance of the structure, which is still pending.

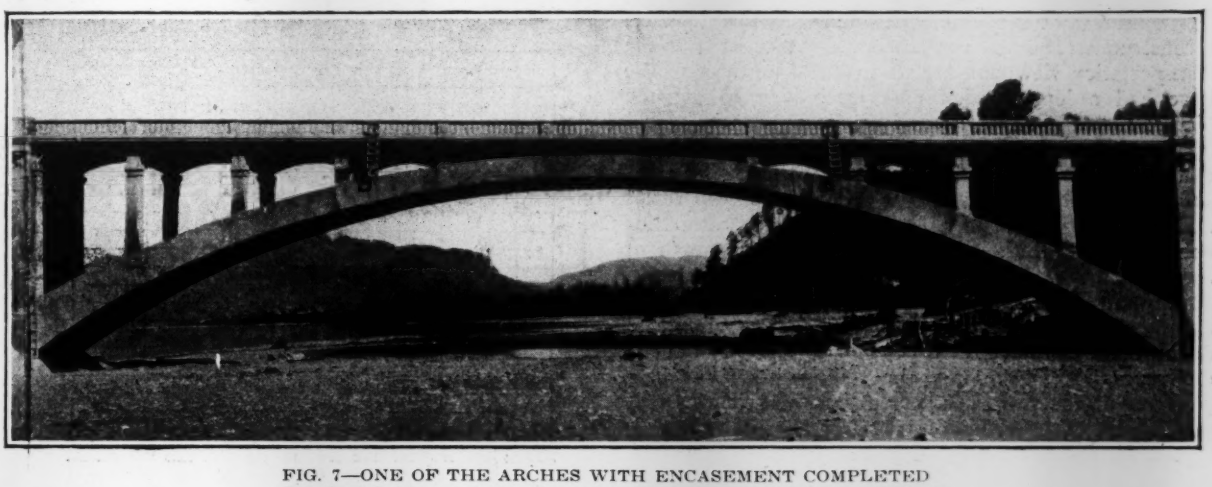


FIG. 7—ONE OF THE ARCHES WITH ENCASEMENT COMPLETED
The final finish was a thin flat coat rubbed with burlap while still fresh.

Seventh and Last Article on
HIGHWAY MAINTENANCE

Federal Influence and Authority

By Thomas H. MacDonald
Chief, U. S. Bureau of Public Roads, Washington, D. C.

IF TODAY all the maintenance-of-way forces were taken simultaneously from the railroads, how long would rail transport continue to function? Certain fast schedules necessarily would be abandoned at once. On some lines for a short time, and on others for a longer period, a pretense of service would remain, but it is a matter of common understanding that our whole scheme of rail transportation is dependent upon continuous and adequate maintenance. A comparison between the physical condition of all of the major lines when first laid down, and now, proves the potentiality that lies within what accounting designates as maintenance, reconstruction and new construction. But these from the transportation viewpoint are all a part of a process. We have had a long enough experience now to get the picture that the furnishing of rail transportation facilities to large areas and over long mileages is not an operation defined by time limits or fixed financial expenditures, but is rather a never-ending process of repair and renewal, of constantly improved facilities, of nothing permanent but the general location and the growth of the demand for service. The process by which rail transportation has been brought to its present state of development presents a parallel to the highway situation. In detail there is much divergence, but the outstanding difference lies in the way the rolling stock has been placed upon the roadways. Rolling equipment was only put in service by the railways after the roadways designed for it were ready. It was controlled in weight, number and speed.

Motor vehicles were put in service on highways that, if improved within any reasonable meaning of the term, had been built to provide for a totally different kind of equipment and power. Over the period of the last ten to fifteen years, the traffic upon the highways as a whole, relative to their capacity, has not been controlled in weight, number or speed. The rising flood of motor vehicles has presented a decade of emergency conditions for highway administrators and engineers to meet. As the data for this article have been brought together, they have developed a far deeper appreciation of the actual accomplishments of these officials and particularly of the intelligent efforts of the state highway departments.

The United States has become the leading exponent of quantity production through standardized methods and designs. The public does not look questioningly beyond that production which springs from new materials and complete processes, but the today's quantity and quality service of highways with its availability to the far-reaching dimensions of the physical nation is not one of these. Rather it is the product of maintenance. It is the result of intelligent, constant effort to salvage, improve and extend facilities rapidly. Wholly new construction has been a large factor, true, but itself relies wholly upon adequate maintenance—maintenance in its newer conception, which now starts even before the contractor has left the job.

Maintenance Impulses—The efficient functioning of the state highway departments and the annual income from the motor vehicle user—license fees and gas tax —are the foundations under this modern highway service. The federal highway legislation has been a powerful force in establishing and holding to adequate and continuous maintenance as a first principle of highway administration. The distribution of war surplus trucks, tractors, repair plants, spare parts, incidental tools and materials, all in generous quantities, to the states, equipped the highway departments and did more than any other one thing to establish highway maintenance

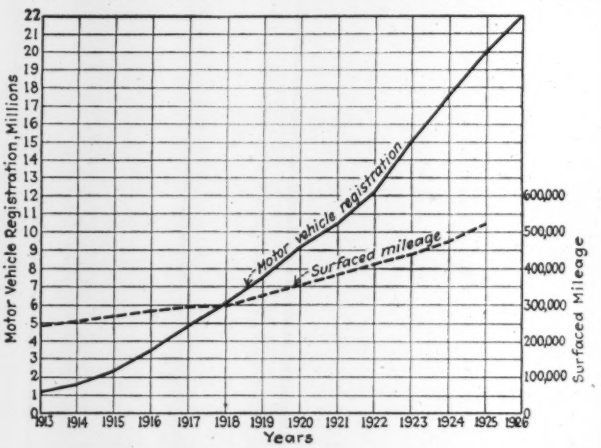

Motor Vehicle Registration, Millions
Surfaced Mileage
Years
Motor vehicle registration
Surfaced mileage
1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926

FIG. 1—MOTOR VEHICLE REGISTRATION AND SURFACE MILEAGE IN UNITED STATES

quickly on an effective nation-wide basis. The research and investigation, both physical and economic, of highway design and utilization have provided the knowledge upon which to develop a more effective maintenance technic. While the methods of keeping maintenance cost records are not yet fully informative or standardized over sufficient areas, nevertheless highway administration has progressed to a very definite recognition that two considerations have the greatest influence in determining the limitations of roadway types and new construction or reconstruction policies. These are the adequacy and the annual cost of highway service. The efficiency of highway administration, in a constantly increasing degree, will be measured in terms of these two factors. Their correct application will properly balance the annual program of maintenance, new construction and reconstruction.

Just what would have been the history of development of highway transport had there been no World War is difficult to visualize. What actually happened was so sudden and so extensive that the demands for serviceable highways could not be and were not met by new construction. In fact, highways that had been improved up to the prevailing standard and were believed reasonably adequate were so seriously damaged

during 1916 and the immediately following years as to convince the public they had entirely failed. Had this been true or had it been impossible through intensive and well-organized maintenance to repair and to raise to a higher state of improvement much of the old surfaced mileage, there would not be in use today a very large percentage of the roadways which are carrying a heavy and constantly growing traffic. The potentialities of modern maintenance and betterment were not understood because not experienced prior to 1919.

Maintenance Needs—The graph, Fig. 1, shows the growth in registration of motor vehicles and the increase in the mileage of surfaced roads. In these figures, credit is given for all roads reported as surfaced by states and counties. There are included many miles of natural sand, clay or gravel surfaces and many more miles that, like Topsy, just grew without intelligent direction, conception or efficient expenditure. The national dependence upon maintenance is convincingly shown by the separation of this total mileage into the surface types now in service, Fig. 2. These two graphs illustrate the demand and the response. In no similar length of time has any nation or any private agency provided physical works of the dimensions of the highway mileage now in service. This fact leads to the incorrect conclusion that we approach a lessened construction

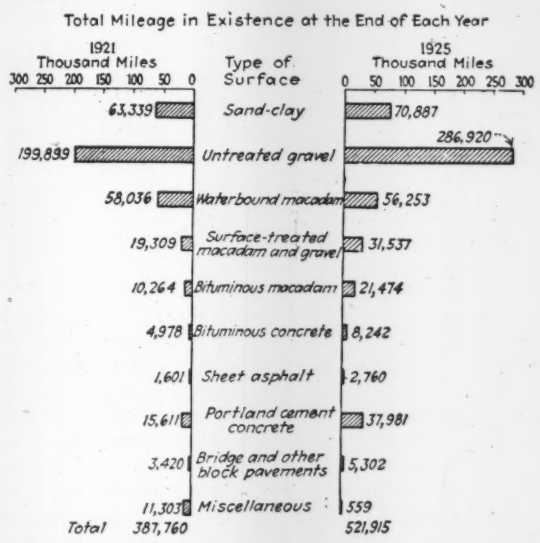


FIG. 2—TYPES OF SURFACED ROADS IN 1921 AND 1925

program. The opposite is true. The whole highway structure rests on continuous maintenance, but a large percentage of the surfaced mileage is not economically and not securely held in service.

Whether long mileages of low-cost roads, salvaged roads, or reconstructed roads are or have been the correct technical solution, is not a question. When a whole nation suddenly takes to wheels driven by everywhere available and heedlessly expended supplies of low-cost gasoline, it wants and will have some place to go. Parking space alone for cars manufactured absorbs about all the mileage the construction of federal-aid roads supplies:

Year	Cars Manufactured (Allowing 20 Feet per Car) in Miles	Miles of Federal-Aid Road Completed
1919	7,330	160
1920	8,440	1,510
1921	6,050	5,788
1922	9,680	10,247
1923	14,890	8,820
1924	13,160	8,620
1925	15,750	11,328
1926	16,000	9,417

The gasoline used at the rate of 450 gal. per year per car would fill a lake two miles square and ten feet deep. The horsepower developed by this lake of gasoline and transmitted as pushing and abrading forces must be absorbed by the surfaces of our roads. Their physical structure receives the pounding of traffic with impact forces multiplying the actual weight many times.

In addition there are the rupturing stresses of expansion and contraction from thermal and moisture changes, the wash of storm water, the waste of the wind and

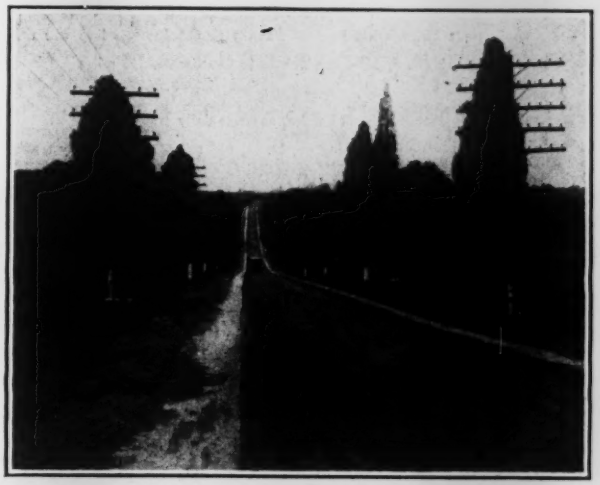


FIG. 3—BALTIMORE-WASHINGTON ROAD; CONCRETE SHOULDER WORK

Originally 12 to 14-ft. macadam, light construction. Widened and crown flattened, now carrying about 3,500 vehicles per day. The service rendered by this road is the product of meticulous maintenance.

the weakening and deterioration of materials through heat, cold and moisture. All of these have been more or less definitely measured. The warping or curling of a concrete slab roadway between the day and night temperatures may lift the slab from support of its subgrade alternately at the center and at the edges. Too soft asphaltic tops are rolled out of shape under heavy loads. The kick of motor wheels and the wind waste binder and

TABLE I—AVERAGE DAILY TRAFFIC FOR THE TOTAL MILEAGE OF STATE HIGHWAY SYSTEMS

State	State Highway System Mileage	Per Cent of Total Rural Mileage	Average Daily Motor Vehicle Traffic	
			Total	Trucks
Maine (1924 summer)	1,630	7.1	1,044	94
New Hampshire (1926 summer)	1,454	11.3	916	51
Vermont (1926 summer)	1,043	7.2	702	41
Connecticut (1923)	1,114	7.2	1,018	147
Pennsylvania (1924)	10,274	11.0	635	57
Ohio (1925)	11,000	13.0	538	51
Cook County, Ill. (1924 summer)	418	25.0 (Approximate)	2,371	146

body of gravel and waterbound macadam surfaces to fields and side ditches. Storm water cuts out embankments and subgrades, tears viciously at side ditches and piles débris against culverts and bridges. The mud-bottom streams common to the agricultural areas may deepen 15 to 20 ft. in one storm at bridge foundations.

Traffic Distribution Complication—Traffic grows apace. The public little realizes the amount of service the more heavily traveled highways are rendering. Both in numbers and tonnage the totals are astonishing. But the problem of maintenance would be greatly simplified if traffic were more evenly distributed. These facts are well illustrated by the summaries from recent transport surveys in the several states, Table I.

Generalizations and averages are deceptive. This is particularly true in states like Ohio and Pennsylvania which have a very large total mileage under the jurisdiction of the state highway department. The maintenance problem becomes very different when a main route is considered, even though long distances are included:

AVERAGE DAILY TRAFFIC FOR MAIN ROUTES

Ohio
Chicago—Buffalo (U. S. 20) 157 miles
Conneaut, Ohio (Eastern State line) to Fremont (where routes divide) average daily traffic 2,450.
National Road (U. S. 40)
Average daily traffic 1,750 (159 miles from Brandt east to the Pennsylvania line; The section west of Brandt to the Indiana line was unimproved).
Dixie Highway (U. S. 25) from Toledo to Cincinnati, 215 miles
Average daily traffic 1,700.
Pennsylvania
Lincoln Highway (U. S. 30)
Trenton to Pittsburgh, 285 miles, average daily traffic 1,780.
U. S. Route 1
Portland, Maine to Washington, D. C., 608 miles, average daily traffic 4,200.

But even main route traffic is not a true indication of the maintenance problem. The intensive problem of providing and keeping in repair adequate highways is that of the gateway—the roads which provide the ingress and egress for our large cities and carry the traffic within what may properly be called the metropolitan areas, covering a radius of forty or fifty miles from the focal points of large population centers. The gateway problem on main highway routes is the big highway problem, Tables II and III.

TABLE II—AVERAGE AND MAXIMUM DAILY TRAFFIC ON STATE HIGHWAYS NEAR THE GATEWAYS OF THE LARGER PENNSYLVANIA CITIES

City	Number of State Routes	Average Daily Traffic: Motor Trucks	Passenger Cars and Motor Trucks	Maximum Daily Traffic
Philadelphia	13	4,938	47,000	123,500
Pittsburgh	9	2,491	19,700	52,760
Scranton	5	1,762	14,000	52,460
Harrisburg	6	2,424	22,100	57,100

TABLE III—AVERAGE AND MAXIMUM DAILY TRAFFIC ON STATE HIGHWAYS NEAR THE GATEWAYS OF THE LARGER OHIO CITIES

City	Number of State Routes	Average Daily Traffic: Motor Trucks	Passenger Cars and Motor Trucks	Maximum Daily Traffic
Cleveland*	17	2,907	32,938	75,895
Cincinnati†	11	2,201	15,739	36,479
Toledo	10	2,254	21,612	49,941
Columbus	11	1,428	19,332	44,860
Akron	9	2,136	18,561	42,874
Dayton	12	1,688	19,972	46,160

*Includes East Cleveland, Lorain and incorporated suburban areas.
†Includes incorporated suburban areas, but does not include traffic crossing the Ohio River.

Maintenance Factors—While maintenance is a difficult, unending task in every state, the combinations of the conditions which are the most effective in the tearing down processes are not found universally. The states on both sides of a line from Boston, Mass., to New York City, to Chicago, and the cities of the Mississippi valley extending to the Missouri or just beyond on the west and to the Ohio River on the south, including the state of Missouri, present the most difficult maintenance problems. There is a wide range of conditions in this area, but within this roughly defined portion of the United States the combinations of factors are formed that are the most disastrous to our highways. Here are found, together, thermal ranges from 100 deg. F. to 30 deg. below zero; long periods of alternate freezing and thawing; very finely divided subgrade soils; the heaviest traffic, both in weight and number; and rain, snow and ice for long continuing periods. Mix all these elements together and they are warranted to necessitate the most difficult and most expensive road maintenance. Outside of the area described, all of these factors are not found together in any considerable area, or, if found, their degree of "badness" is less.

Given any type of road, the factors listed form the worst possible combinations to meet. Ten years ago, however, there were only small mileages of the paved types of roadways, confined almost wholly to the eastern states, and these had not been designed for the wartime truck loads. The surfaced mileage consisted almost wholly of macadam—waterbound, surface treated or penetration — and gravel, varying between wide limits of stone content, from pebbles down to the sand clays—natural mixes. Such roadways became quickly inadequate with the great increase of motor traffic. But they as well as large mileages of unsurfaced soil roads, much of which were not superficially well drained, had to be held in service. Such a serious emergency called for much larger and more vigorous maintenance organizations, and those states with well-established highway departments quickly expanded their maintenance forces. The newer highway departments came into being with maintenance as a major function. With few exceptions, all the state organizations grasped quickly the size and seriousness of the problem confronting them. They attacked the problem with technical skill and broad vision and quickly crystallized a revolutionary administrative policy that has made possible the extensive mileage of highways in service today.

FIG. 4—FINE CRUSHED ROCK SURFACE IN THE WEST
The fine crushed rock roads largely used in the west are adequate for the traffic but the wastage from the surface is too great and resort is had to bituminous treatments.

This newer policy finds its best expression in the determined efforts of the highway officials, state and local, to keep the highways in usable condition without accepting or excusing defeat because of type or traffic.

Federal Influence—Previously, if judged by today's standards, no roads regardless of type had been adequately maintained over sustained periods under local jurisdiction. The fact was recognized and criticized vigorously. But effective measures to establish state control and to cure the lack of competent engineering direction, in a large majority of the states, were being even more vigorously, and certainly more effectively, opposed by selfish interests and by political demagogues.

Just at this crucial time came the first federal highway legislation, the Act of 1916. Two outstanding principles of highway administration were written into this legislation as requirements contingent upon the acceptance by the states of the co-operation in road improvement offered by the federal government. These are:

That each state should have established an adequate highway department; and

That each state having received federal funds is obligated to maintain in satisfactory condition the roads so built.

In 1916, one-third or more of the states had no highway department. The road work was wholly under local control. Nearly another third had organizations with limited authority or insufficient funds. Thus as late as 1916, at least two-thirds of the states were not effectively organized to construct and to maintain their main highways.

A fatal weakness in the financing followed under local control was the lack of maintenance funds. This was particularly true when county or district bonds were issued to undertake a relatively ambitious program of new construction. Communities heavily in debt saw their roads rapidly deteriorating and lost faith. They had believed in permanent roads and failed to provide maintenance funds. The federal aid road legislation of 1916 provided:

"SEC. 7. To maintain the roads constructed under the provisions of this act shall be the duty of the states, or their civil subdivisions, according to the laws of the several states. If at any time the Secretary of Agriculture shall find that any road in any state constructed under the provisions of this act is not being properly maintained he shall give notice of such fact to the highway department of such state; * * *."

This legislation required the assent of the state through its legislature to its terms. Highway legislation in all the states quickly followed. Thus within a two- or three-year period every state had enacted additional highway laws. Some, it is true, were so meager they barely met the federal requirements, but even these contained the essential provision for a state department, and fixed responsibility for maintenance of road projects on which federal funds were used. As the motor vehicle had by 1916 increased to such numbers that a considerable revenue could be obtained through license fees, this revenue was quite generally dedicated first to maintenance. Very soon, in 1919, the first tax on gasoline appeared, which has proven to be such a popular method of raising additional revenues that all but two states now tax gasoline, varying from 2 to 5c. per gallon.

To what extent the federal legislation has held these revenues from the road user in large measure for road purposes is known only to the highway officials, who have fought off attempted diverting of these funds for other purposes.

Highway Expenditures — The following schedules, Tables IV, V and VI, are taken from data collected by the Bureau of Public Roads. For state funds, they are reliable. For the local funds, they are gathered largely from original sources and are as accurate as the accounting records of the local governments. These vary between wide limits and extreme accuracy is not claimed, but the totals present a reliable survey.

These schedules show: First, the division of a billion-dollar road program between state and local control and the tendency toward, rather than away from, greater state control; second, the increase in maintenance expenditure; third, that maintenance is absorbing 30 per cent of the total funds plus equipment costs chargeable; fourth, that state highway maintenance absorbs about 20 per cent plus equipment chargeable; and fifth, that the road user is paying a constantly increasing percentage of the total cost.

These totals are used for construction, maintenance and miscellaneous, as shown in Table V. The miscellaneous item includes payments of interest and principal on bonds and equipment. The latter item is largely for maintenance equipment.

TABLE IV—HIGHWAY FUNDS, TOTAL EXPENDITURES

Year	Total Highway Expenditures	State	Local
1923	$1,000,000,000*	$447,362,358	$552,637,642*
1924	1,181,521,115	605,665,207	575,855,908
1925	1,288,939,707	649,125,101	639,814,606
1926	1,053,440,210*	621,744,210	431,696,000*
1927*	1,136,257,055	658,958,055	477,299,000

*Estimated.

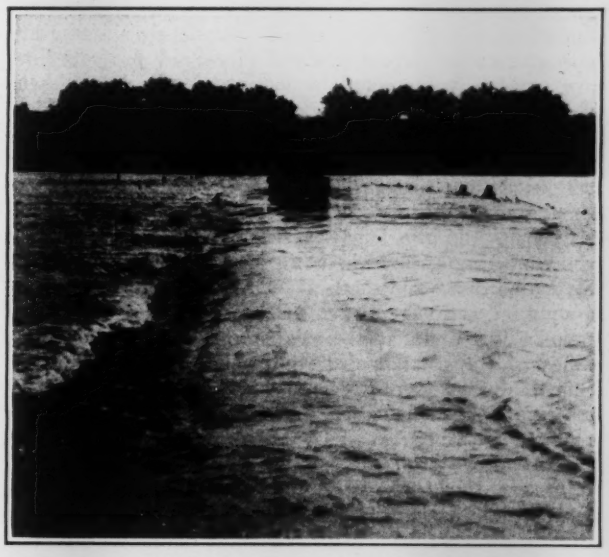


FIG. 6—STORM PICTURE FROM ARKANSAS SHOWING CONCRETE ROADS DURING FLOODS

The contribution from the motor vehicle user in license and gas taxes alone, and used for the general purposes shown in Table V, was, for 1926, Table VI, nearly $460,000,000.

Federal Contract Methods—There is a total of 287,900 miles in the state highway systems. The average cost of maintenance for 1926 was approximately $436 per mile. This figure is not indicative of maintenance costs for any types of roads, but does indicate the average cost to the nation of each mile of the state highway systems. The federal highway system includes 185,772 miles which run coincidently nearly to this extent with the state highway systems. The maintenance requirement of the federal legislation would offer perhaps the greatest opportunity for friction in the co-operative relationships were it not for the fact that the state and federal forces have come to look at maintenance from exactly the same viewpoint.

As soon as construction is completed on federal-aid projects, the maintenance inspections by the field engineers of the Bureau of Public Roads begin. There are twelve federal districts, each with a district engineer

TABLE V—HIGHWAY FUNDS CLASSIFIED EXPENDITURES

Year	State			Local		
	Construction	Maintenance	Miscellaneous	Construction	Maintenance	Miscellaneous
1923	$279,245,875	$75,329,158	$92,787,325		Data not available	
1924	381,080,058	104,806,557	119,778,592	$255,949,803	$192,372,152	$127,533,843
1925	386,966,871	119,303,560	142,855,670	264,965,764	196,573,516	178,275,926
1926	351,222,337	125,617,313	144,904,560		Data not available	

*Data not available.

in charge. The engineers who under the supervision of the district engineers work with the highway departments, in general, are located in the states. They are constantly on the road and know in intimate detail the projects during their construction and the later maintenance. Last year in their inspection of federal highway projects, the engineers of the bureau traveled 1,723,000 miles, the greater proportion of which was on the federal highway system. The force is stable. In a number of states the federal engineers have been a large factor in preserving continuity of construction and maintenance policies because of a constantly shifting and changing state department. Federal-aid projects thus are constantly inspected by engineers who know them. Copies of inspection reports constitute a memorandum of needed repairs for the state.

Twice each year the individual reports of maintenance conditions are summarized at the Washington office of the bureau. A project listed as unsatisfactory is followed up and the black mark only removed when, as shown by actual field inspection, it is again in satisfactory condition. On the first of January, 1927, the semi-annual inspection report covered 57,408 miles of projects then under maintenance. This included all but eight miles of the total projects built with federal aid. Of this total, 55,756 miles were reported in a satisfactory condition of maintenance, and 1,652 miles, or about 2.8 per cent, were in an unsatisfactory maintenance condition.

Future Problems—Maintenance, however good, fails when traffic passes the maximum limit for the type. So the big problem now, after ten years of building federal projects, is to raise the roadways to a type that can be maintained under the enormous increase in traffic.

In this connection, Figs. 1 and 2 show the existing facts, but they are incorporated rather to show tendencies, since in a work of the magnitude of highway improvement the direction in which growth is taking place is at least equally important with the presently existing situation. Fig. 1 shows how much greater has been the acceleration of the individual in equipping himself with motor vehicles than of the nation in providing itself with adequate highways.

An important function of the federal maintenance requirement—perhaps it may prove to be the most important—is that of determining the point when reconstruction or the stepping up to higher types of surface is needed. Already the future program of federal-aid projects in one large state is based upon the maintenance records. These records point out clearly the difference between satisfactory maintenance and satisfactory service. When adequate maintenance efforts fail to produce satisfactory service then the type must be changed.

When the war ended we were left with a large amount of surplus war equipment, some in this country and a great deal abroad. Congress provided for the distribution of such surplus as was suitable for road building purposes to the states. This produced two major effects. States which up to that time had not been able to establish adequite maintenance because of lack of means had at once placed in their hands the equipment which could be used for this purpose, and because it came as a free distribution the public accepted without much protest its utilization in numbers on the highways. The second effect was equally important. The use of the equipment enabled the state highway departments to hold the existing roads in reasonably serviceable condition while the construction programs were being put under way. Possibly nothing added more to the support of the highway departments than the widespread betterment of conditions made possible not alone through the equipment distributed by the federal government, but by reason of the fact that the public became accustomed to the possession and use of a large amount of equipment by the state departments. There were distributed to the states approximately 36,000 motor vehicles and large quantities of spare parts, explosives, hand tools and other surplus that could be used advantageously for road maintenance. In all, 753,000,000 lb. of material were distributed, the value of which was estimated at $222,000,000. There was considerable waste of course in an operation of a purely salvaging nature, but the foundation of the maintenance equipment in all but a very few states has been this war surplus, and through its use the nation obtained a return many times greater than could have been obtained by any other disposition.

Maintenance records have not as yet been reduced to a comparable basis between the states. A committee of the American Association of State Highway Officials is working toward this end, but to establish uniform records is far less important than to establish adequate records, and adequacy in this sense means the actual expenditures co-ordinated with the quality of service, the amount and kind of traffic, and the division of expense between roadbed and road surface. For example, the cost for a certain stretch of road in 1926 is reported as $3,714. Here the records were separated, however, and the cost of the pavement maintenance per mile was $563. Another and longer route cost an average of $1,076 per mile to maintain, but the cost of pavement maintenance was $233. Here are the actual costs on which the pavement costs themselves are too high, but

TABLE VI—HIGHWAY FUNDS, SOURCES OF REVENUE

Year	State				Local			
	Motor Vehicle Tax	Gas Tax	Property Tax	Bonds	Motor Vehicle Tax	Gas Tax	Property Tax	Bonds
1923	$147,675,966	$15,872,844	$24,348,378	$88,786,784	..... *	..... *	..... *	..... *
1924	174,816,973	47,810,615	18,282,878	101,653,327	$26,856,176	$16,971,402	$376,787,861	$157,536,944
1925	199,845,163	89,328,340	21,489,004	141,402,022	46,545,445	24,833,979	412,825,227	144,413,116
1926	224,551,631	134,303,154	18,278,994	103,846,301	57,156,282	43,609,479	..... †	..... †

*No data secured for local revenues 1923. †Data in process of collection.

they are not relatively nearly so high as the roadbed costs. These point unfailingly to lack of adequate width and poor side ditch and shoulder construction.

Research has pointed out the weak points of our roads and has to a degree determined the capacity of given types of construction. Conditions vary so widely, however, that maintenance costs and service records are necessary to check against proposed designs no matter how perfect theoretically.

In summary it may be said that the technic of maintenance, the handling of equipment, the use of materials, have been developed to a point much further advanced than the economic considerations, but there is no excuse now for not taking full advantage of the information furnished from maintenance records upon which to determine a really scientific administrative plan for administering highway funds. The use of the mechanical tabulating machines has made possible the utilization of quantities of data because they quickly and economically

FIG. 5—INADEQUATE ROAD WIDTH
High maintenance costs have been commonly attributed to wear and tear on the roadway proper. Such costs are more than likely to be due to inadequate widths or improper edge, shoulder or side ditch construction.

sort, classify and summarize the contained information. The highway information of the future will be gained from such studies, and sound policies of highway administration will be founded upon maintenance records both of cost and adequacy of service.

It would not do to conclude this article with the chance of having produced an attitude of composure. Our highway system is decidedly in an unbalanced status. There were added to the mileage of state roads last year nearly 13,000 miles, due undoubtedly to the desire to get these roads under state maintenance and state construction, which indicates the political strength of this urge. There are now 287,900 miles in the state highway systems, of which 163,000 miles, or 57 per cent, are surfaced. Of this 57 per cent, 109,000, or 67 per cent —two-thirds of the entire surfaced mileage on the state systems—is of what may be termed transient types; that is, before economic maintenance results they must be largely lifted to higher types, or the present types greatly improved.

The local road situation gives even greater reason for concern. Of the 2,731,000 miles remaining after taking out the state mileage, 376,000 miles are surfaced, or 14 per cent. Of this surfaced mileage 347,000 miles, or 92 per cent, are of the same types as those listed as transient for the state systems; that is, they include the sand-clay, gravel and waterbound macadam surface types.

These facts are certainly more convincing of our utter dependence upon maintenance than a volume of argument.

Railway Freight Traffic and Facilities of Chicago Terminal District

THAT 87 per cent of the vast railway freight traffic of the Chicago terminal district is local traffic, originating in or destined to points within this district, is a rather surprising conclusion presented in a comprehensive report made for the General Managers Association of Chicago, on the basis of an extended study of the situation. In other words, with an average of 34,791 cars handled daily within the district, 30,232 cars constitute local traffic, and only 4,559 cars (or 13 per cent) are in through traffic from and to points outside of this district.

In some previous studies and reports on Chicago's railway traffic problems, particular stress has been laid upon the through traffic, and upon methods of bypassing this traffic around the city so as to keep the through cars clear of the congested local terminals. From this latest report it appears that the through traffic is a minority that is provided for fairly well, and that future important improvements would be rather in connection with local traffic and its facilities. For instance, it is shown that much effort is required in collecting cars that have been unloaded in the district and then redistributing them where and as needed. Of the through cars, 85½ per cent require interchange between different railroads, while 14½ per cent come in and go out over different divisions of the same railroad. Furthermore, 78 per cent of the interchange cars have to be handled by intermediate railroads connecting the delivering and forwarding lines.

This terminal district is a crescent-shaped area of 1,750 square miles, with a maximum width of 40 miles, lying between Lake Michigan and the belt line of the Elgin, Joliet & Eastern R.R., which line extends in a broad curve from Waukegan, Ill., to Porter, Ind. Within this district are 32 lines of railroad operated by 22 trunk lines, besides seven belt or switching lines and eight industrial railroads, making a total of 37 operating lines.

Further, although the 22 trunk lines enter the congested downtown zone of the district, they are all accommodated by eight gateways or rights-of-way. In fact, there are really only seven gateways, since the rights-of-way serving two groups of lines are parallel and contiguous. Within this district there are 3,064 miles of main track, 4,662 miles of yard tracks and sidings, 206 freight switching yards, 372 team yards, 255 freight stations, 100 car repair yards with capacity for 9,237 cars, 82 enginehouses with 1,279 stalls, and 12 locomotive repair shops. In addition, there are 4,330 industries served by private tracks.

Efficiency and expedition, as well as economy, in the handling of this heavy and complicated traffic are promoted largely by joint use of facilities, even among competing lines; also by numerous operating agreements involving two or more railroads, and by uniform switching tariffs.

Sulphur Compound Used to Point Tile Liners in Sewer

Gases Excluded from Concrete by Sealing Vitrified Clay Liner Joints with Sulphur, Sand and Ground Silica

AFTER a study of various types of linings, the Los Angeles County Sanitation Districts decided to use vitrified clay tile liners and to point up the joints with a sulphur compound in the construction of large monolithic concrete outfall sewers. The sewer system being constructed by the Los Angeles County Sanitation Districts will serve an area of 200 sq.mi. As some of the laterals connected to this system will be 30 mi. from the outfall and retention periods as high as 12 hr. will

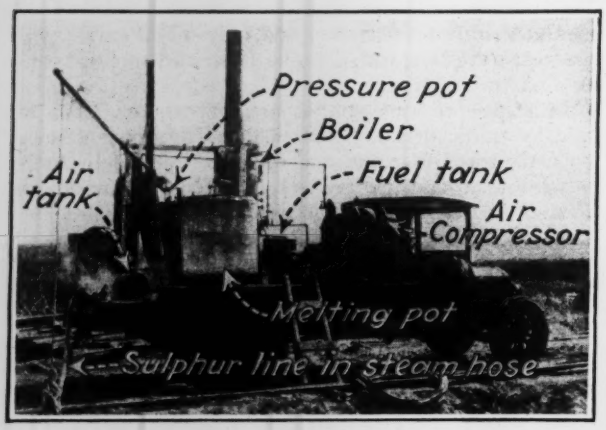


FIG. 1—PORTABLE RIG FOR HEATING SULPHUR COMPOUND

This plant moves along the trench so as to be as near the work as possible. The hose used is 25 ft. long.

occur, an extremely septic condition will exist near the outfall.

For more than three years experiments have been carried out with various protective coatings for the inside of large monolithic concrete sewers, and vitrified clay blocks, Fig. 2, have been selected as the best form of lining. (See *Engineering News-Record*, Jan. 27, 1926, p. 18, for description of the experimental sewer.) Because of irregularities in the tile, it is impossible to obtain absolutely tight joints between adjacent blocks without a mortar joint. Attempts were then made to secure a satisfactory jointing material which would not disintegrate and permit gases to reach the concrete. The result of the study was the selection of a compound of sulphur, sand and ground silica, using 10 parts sulphur, 7 parts clean sand passing a 50-mesh sieve and 3 parts of finely ground silica, by weight. This mixture becomes a fluid mass at 250 deg. F. and crystallizes rapidly at a somewhat lower temperature, while it becomes viscous when overheated a slight amount. Due to this limited temperature range of application, it was necessary to develop a means for maintaining the compound at a constant temperature while being applied. After attempt- to use different methods, a complete heating outfit with air compressor, steam-jacketed heating kettle, steam-jacketed pressure delivery tank and steam boiler, was successfully used, Fig. 1. The ingredients of the joint-

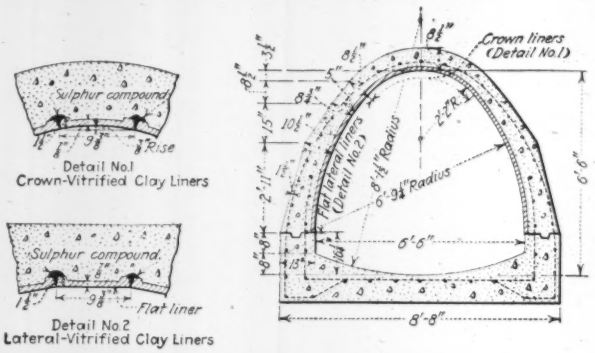


FIG. 2—TYPICAL SEWER SECTION WITH LINER DETAILS

ing compound are mixed together in the heating kettle by first raising the sulphur to about 250 deg. F. and then adding to it the previously dried sand and powdered silica, a little at a time, until the entire amount is in suspension in the hot sulphur. The mixture is stirred mechanically until all foaming ceases, indicating that every bit of moisture has been eliminated. The compound is carried from the steam kettle into the pressure tank by means of ladles. The pressure tank is fitted with a 30-mesh screen which removes particles of unmelted compound or lumps of sand. An airtight cover is then bolted to the top of the pressure tank and air at 40-lb. pressure is admitted through a valve in the lid. The pressure tank is also fitted with a mechanical agitator. A flexible steel hose, similar to a pressure grease gun hose, is attached to the bottom of the pressure tank. This hose is fitted with a metal nozzle and encased in an ordinary rubber steam hose. The flexible metal hose

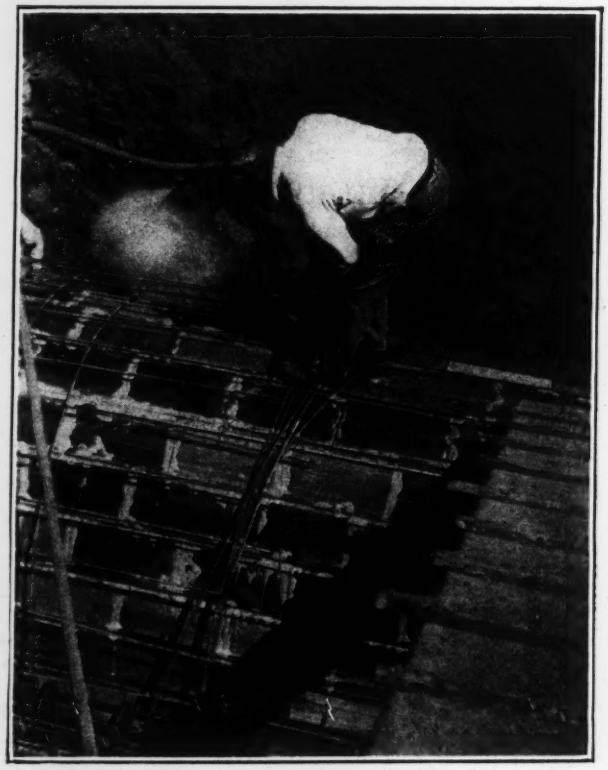


FIG. 3—WORKMAN APPLYING SULPHUR COMPOUND

Note exhaust pipe from the encasing steam hose. Exhaust is returned from the nozzle to be out of way of operator.

has an inside diameter of $\frac{5}{16}$ in. while the inside diameter of the steam hose is 1 in. In this way steam is passed around the metal hose, heating it to a point near the end of the nozzle. Compressed air is forced into the pressure tank and the molten compound flows out through the metal hose in a small stream. The flow is controlled at the pressure pot as it was found impossible to use a valve near the nozzle.

If carefully operated, the plant is declared to be very successful mechanically. Overheating or cooling has the same effect upon the discharge line and some trouble is encountered at times in getting a flow through the end of the line which is heated only by the flow of the hot material through it. With continued practice, however, a three-man crew using this plant can seal the joints in 100 to 200 ft. of arch per day.

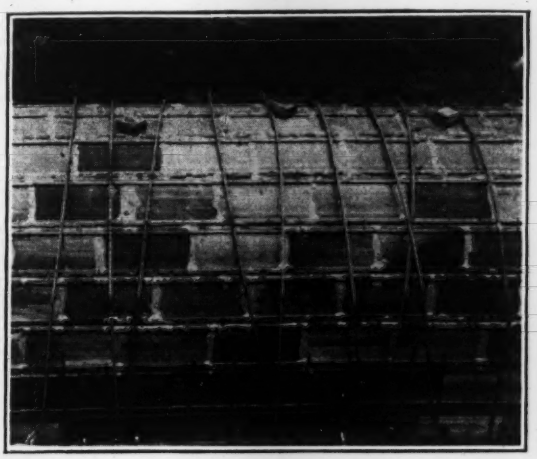


FIG. 4—TILE ARCH WITH JOINT POINTING FINISHED
Note that no sulphur pointing is done below low sewage-flow level. Steel reinforcing not yet fastened.

The material can be applied to the joints at any time after the liners are placed and just ahead of the placing of the arch steel, Fig. 3. The quick-hardening quality is an advantage because it permits the steel crew to follow the sealing operation immediately. The bond secured between the sealing material and the liners is so tight that the men placing the steel and the concrete can walk on the liners without displacing them or disturbing the bond between the liners and the compound. After concrete has been poured, any small holes not completely sealed with the compound are clearly indicated by the appearance of water and cement leaking through to the inside. Any such spots are then sealed from the inside.

In addition to its effectiveness in sealing the joint against acid, the sulphur compound is believed to have other construction advantages. The liners are held rigidly in position, preventing displacement during the erection of steel and the concreting operation; leakage of cement grout through the joints between the liner blocks is also prevented, eliminating the need for a tight arch form and preventing the formation of rock pockets behind the liners. The sewer invert is also left clean after the concreting operation and all pointing on the inner surface of the arch after the arch concrete has been placed is eliminated. The compound does not bond to the salt-glazed surface of the tile liners, and it is considered advisable to remove all of the compound which has spattered on the tile along the joints.

This method of construction of monolithic concrete sewers is believed to resist effectively any destructive agencies which may occur from septic sewage. The blocks used for lining are 9x18 in. The cost of the compound is about 8½c. per square foot of lined area.

A contract, now under way, for 10,000 lin.ft. of 6½-ft. semi-elliptical arch section, monolithic concrete trunk sewer, makes use of the tile liner with the sulphur compound joint. This contract is being carried on so successfully that the use of the tile liner and sulphur compound joint is being incorporated in specifications for trunk sewer construction and will be used in the remainder of the joint trunk outfall, which involves about 12 mi. of similar design monolithic concrete sewers from 9½ to 11 ft. high.

The Callahan Construction Co. and Oberg Brothers are the general contractors on the work now under way. A. K. Warren is the chief engineer of the Los Angeles County Sanitation Districts, and A. M. Rawn is assistant chief engineer and has direct supervision over the construction work. Mr. Rawn furnished the information contained in this article.

Earth Vibrations in Blasting Measured

EXPERIMENTAL studies of the transmission of earth vibrations from heavy blasts were recently made by E. H. Rockwell, dean of engineering at Rutgers University, New Brunswick, N. J., for several stone and quarry companies. Some of the results were briefly indicated in a paper delivered by Professor Rockwell before the National Crushed Stone Association last January. One of the principal objectives was to determine at what distance from a heavy blast there is perceptible effect on or injury to buildings.

Measurements with an instrument of the seismograph type made by Maurice Deutsch, of New York, at various points 600 to 1,800 ft. from a quarry during blasting in the quarry, resulted in recording a maximum amplitude of 0.009 in., with a vibration frequency of about 10 per second. It was calculated from the results that the effect of the blast on an ordinary house 26x42 ft. 30 ft. high 1,800 ft. from the quarry, would be about equal to that of a horizontal static force of 15,000 lb. on the house or by a wind of 12 lb. per sq.ft. against the side of the house.

Other measurements were made with sets of steel pins ¼ in. in diameter set on a hard level surface, a group of pins of different lengths being arranged in a frame so constructed that a pin tipping over would not disturb its neighbor. The pins in the set ranged from a few inches to 15 in. long. Sets of pins were placed at various distances from a quarry on a large number of occasions, and at no point over 200 ft. from the quarry did any of the pins fall during a blast, and even at 200 ft. only the 15-in. pins were affected. Calculations indicated that the maximum seismograph records obtained in the quarry tests represented a vibration almost, but not quite, large enough to tip over the 15-in. pins. It was also concluded that any blast vibrations that would not tip over the 15x¼-in. pins are well within the safe limits of ordinary building construction.

Dean Rockwell concludes that ordinary well-drill blasting as conducted in large quarrying operations produces forces of so small a magnitude that no damage to buildings in the neighborhood can occur unless the buildings are within 200 or 300 ft. of the quarry. He points out that where cracking or damage to buildings has been claimed to result from blasting, the cause was settling of foundations, or basement columns, or settlement due to shrinkage of timber framing, and was not the blasting.

One of a Series of Articles on
OIL FIELD ENGINEERING

Developing a 6-M.G.D. Water Supply for Oil Field Operations

Well Water Supplied by Various Types of Wells and Distributed in 42 Miles of Pipe in the Texas Panhandle Field

WATER in large quantities is a most important necessity in all oil field operations. Each well drilled with cable tools uses between 300 and 400 bbl. of water per day from the time it is started until it is completed. In cementing-off gas, some wells have been known to require as much as 50,000 bbl. before the gas was drowned out sufficiently to proceed with the cementing. Rotary drills as a general rule require more water than do the standard cable tools, an average being about 750 bbl. per day.

Facing such a water consumption possibility in the rapidly developing Texas Panhandle field 60 miles north and east of Amarillo was in the spring of 1926 the most important problem that the oil companies had to solve. It was rendered doubly difficult by the facts that the country was semi-arid for a good part of the year, the Canadian River then being merely a treacherous quicksand bed, that there was no town or railroad within 25 miles and that subsurface water occurred at varying depths and locations in the 200 sq.mi. of "break" country, approaching in many instances a mountainous character.

The Phillips Petroleum Co., one of the first and largest

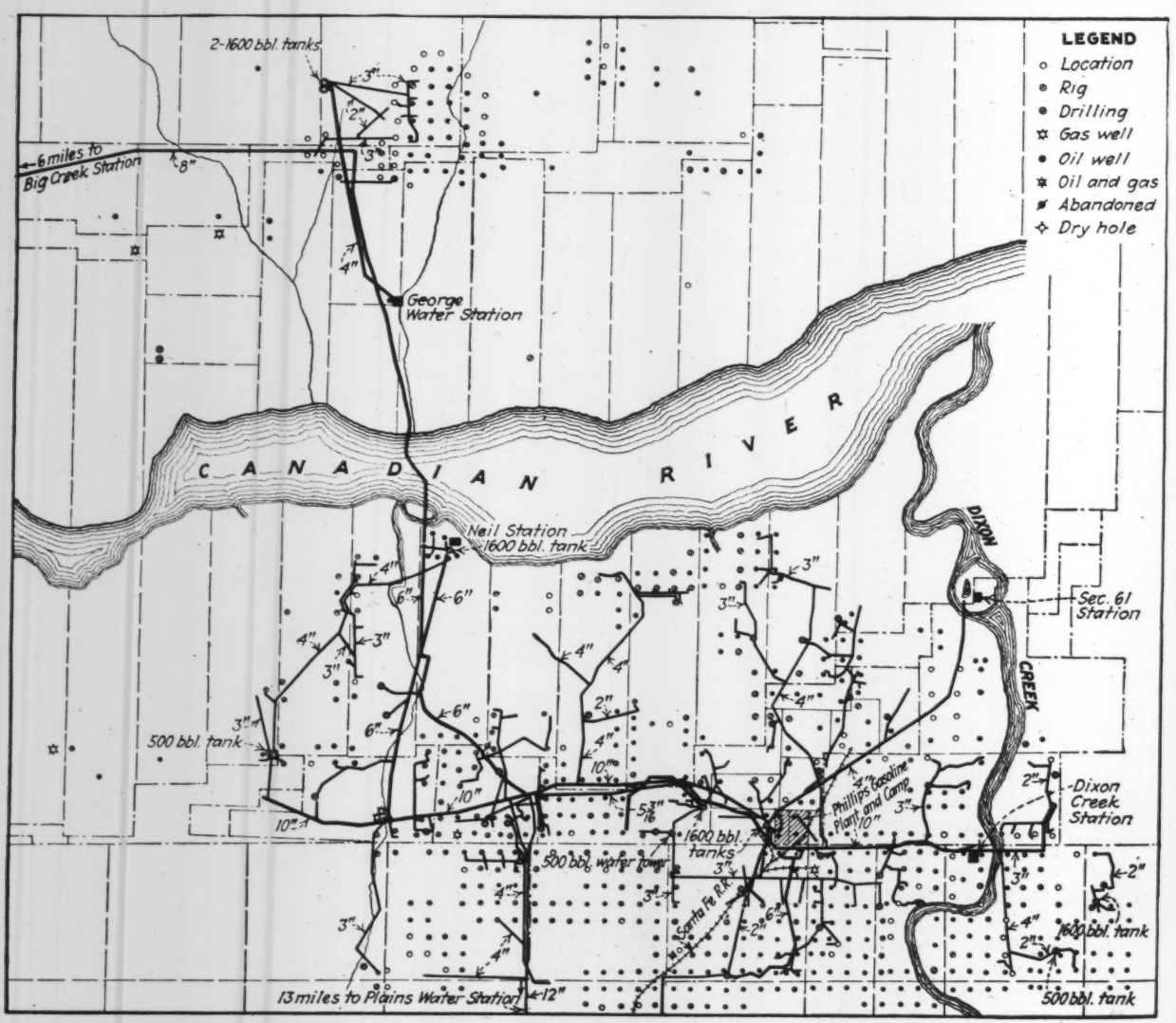


FIG. 1—WATER STATIONS AND LINES SERVING THE TEXAS PANHANDLE OIL FIELD

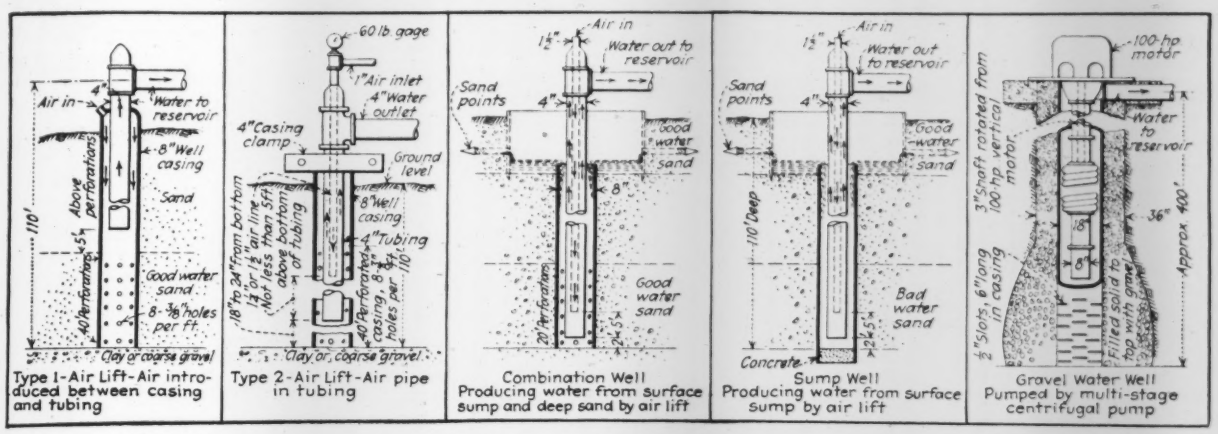


FIG. 2—VARIOUS TYPES OF WATER WELL INSTALLATIONS USED IN TEXAS PANHANDLE OIL FIELD

operators in the field, started immediately to prospect for well supplies for its production needs. These were to be larger than for the ordinary crude oil producer since the company, in addition to its drilling requirements, would need thousands of barrels for the operation of its natural gasoline plants, construction on which had started immediately following the first production in the field. Many unsuccessful attempts were made to locate an adequate supply of water and it was first found not by the drillers but by an oil rig construction gang who struck it while excavating for foundation piers along the Canadian River. This supply was first developed and others followed until in February, 1927, a year later, an available daily supply of 200,000 bbl. was being drawn from at the rate of 100,000 bbl. per 24 hr. One new plant, adding 22,000 bbl., has just been completed and another, which will supply 50,000 bbl., is now under construction.

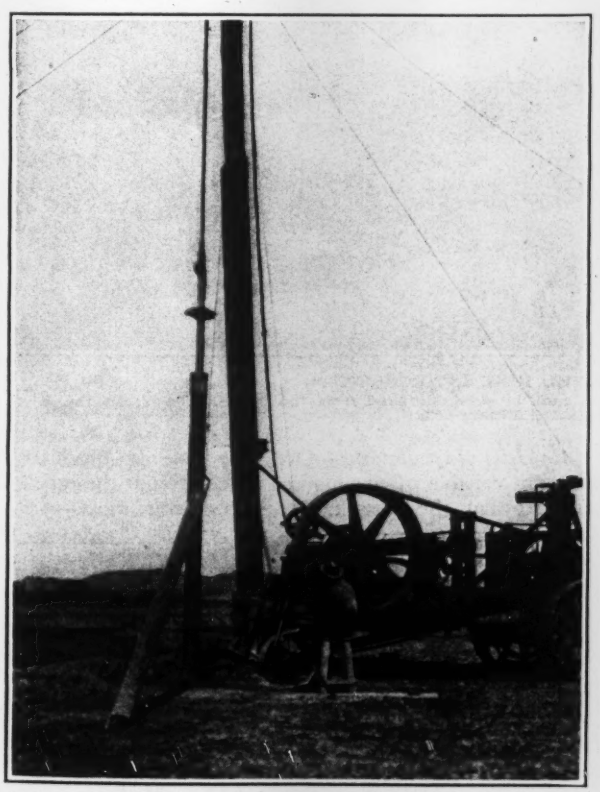


FIG. 3—EQUIPMENT FOR DRIVING WATER WELL CASING ON BANK OF CANADIAN RIVER

Because of quicksand it is practically impossible to drill a well in the usual manner.

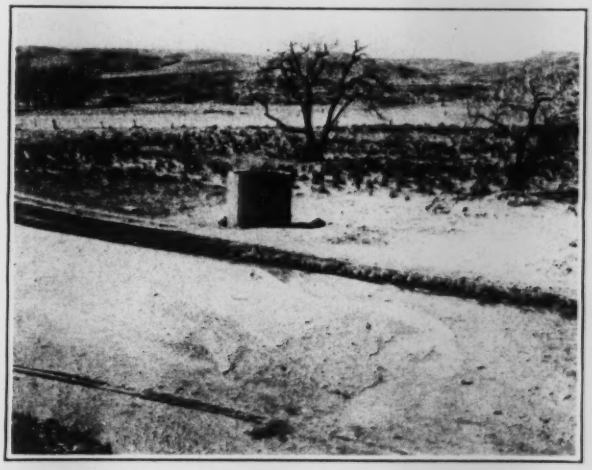


FIG. 4—BARREL SUMPS, 12 FT. IN DIAMETER, BEING SUNK INTO SAND ON BANK OF CREEK

The type of the surrounding country is well illustrated.

The requirements for water had grown so rapidly among other producers in the field that the Phillips Company decided to develop a sufficiently large supply so that some of it would be available for sale. The large investment could thus be partially returned. At the present time this system is supplying practically the whole field with the exception of several of the smaller companies and one or two larger ones who have been able to develop a supply sufficient for their own needs. In addition, the Phillips system is a source of supply for Borger, a boom town of some 30,000 people. Suitable drinking water was so scarce when Borger first opened that there are on record instances where it was sold for 10c. a glass. Of the water supply developed at the present time, 40 per cent is being sold.

The present water system which is being added to has a pumping capacity of 130,000 bbl. per 24 hr. The plan being followed is to keep 50 per cent more water developed than is required and also to keep the pumping

capacity 25 per cent over requirements. In the present system there are three main pumping stations, each having a capacity of about 40,000 bbl. A number of portable and temporary stations also have been used from time to time as the oil field was rapidly extended to outlying points. Most of the water so far developed has come from the south side of the Canadian River, near the present producing wells.

Because of the varying depth and character of the water sand it has been necessary to use a number of different types of wells. Among these are two types of air lifts, regulation sand points, sumps, a well combining a sump and an air-lift installation, and some large diameter deep drilled wells flowed with a vertical-shaft multi-stage centrifugal pump. There is, in addition, a novel method of tunneling for water under construction on the north side of the river. These various type wells, the pumping stations and distribution systems form an interesting water supply installation.

General Conditions—Until recently when the Plains water station, located about 15 miles south of the oil field, was completed, all water varied in total hardness from 8 to 90 gr. per gallon. This hard water comes mostly from the south side of the river. The Plains pumping station, while on the south side of the river, is some 20 miles back and is not in the hard water area. The north side of the river provides several locations for soft water development and it is here that the tunneling method is being used. The ultimate plan is to develop as large a supply of soft water as is possible and to substitute this soft water for that portion of the supply which at the present time is hard, keeping this hard water system as a reserve.

The water supply system has been added to at a rate of about 10,000 bbl. per month over the past 12 months. It is developed only so fast as it can be used, since no storage is available.

Storage might eventually prove to be good policy since all the underground water is moving and that which is not taken is lost. But storage is too expensive and so far the supply has shown no sign of diminishing. The rainfall is about 22 in. per year, concentrated in a few spring months.

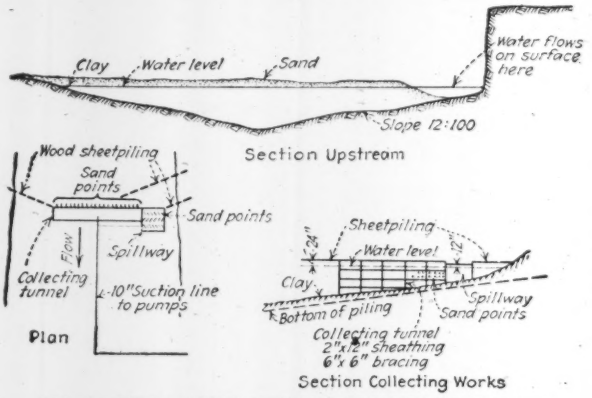


FIG. 5—TUNNELING METHOD TO OBTAIN WATER
Plan and sections of method used to intercept stream flow by means of a tunnel.

FIG. 6—HALF OF WATER TUNNEL SUNK INTO CREEK
Note excavation to left for another tunnel section. Tunnels are sunk by dredging sand from the inside. Eventually the whole tunnel will be beneath the stream bed.

Air Lift Installations—Ordinary drilling machines were not capable of putting the pipe through the quicksand so that the installation process was more of a

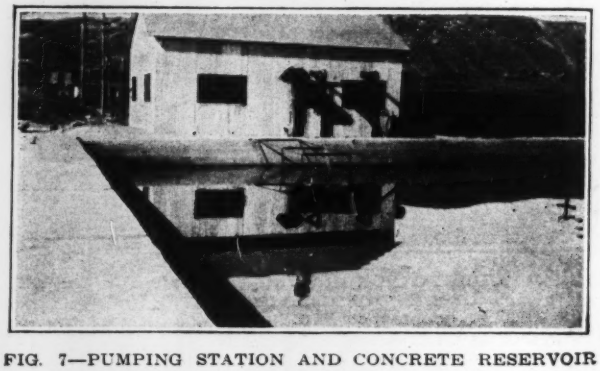


FIG. 7—PUMPING STATION AND CONCRETE RESERVOIR

driving than a drilling one. In one well 140 ft. of pipe was driven and the final hole was only 80 ft. deep, it being necessary then, in order to complete the well, to remove the remaining 60 ft. of quicksand by means of an air-jetting process. Fig 3 shows one of the drilling rigs in which the drill was used only to agitate the sand. As soon as the casing, which was perforated at the bottom for a height of 30 ft. with eight ⅜-in. holes per foot, rested on the solid formation below the water sand, tubing and air pipe were inserted and the well flowed by means of the air lift. About four weeks were required to develop each well. A number of cave-ins resulted from flowing the wells too fast and thus shutting off the water supply. By developing the well slowly the surrounding formations had time to settle and quite efficient wells have resulted.

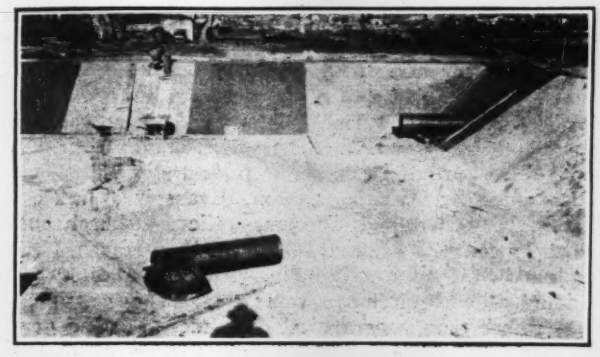


FIG. 8—CONSTRUCTING CONCRETE RESERVOIR FOR OIL FIELD WATER STATION

Another difficulty was experienced where a water well happened to be located near an abandoned oil well whose casing had been pulled. In most of the territory there were two strata of water sand. If a water well tapped only the upper sand and a nearby oil well casing which had penetrated both water sands was pulled the water from the top layer was permitted to escape into the lower layer, thus leaving the water well dry. Several good wells were lost in this manner, but the more recent wells have been put through to the lower water stratum in order to guard against a repetition of this difficulty. The two types of air-lift wells used are illustrated in Fig. 2, as are also the other varieties of well installations.

Sand Points, Sumps and Combination Wells—At a number of the temporary stations ordinary sand point wells were driven, but did not prove very successful having a tendency to clog. At locations where the water was near the surface, large sumps were sunk.

A type of well consisting of a sump from the bottom of which extended air lift installations, has proved very successful. The sump water supply is increased by the use of horizontal sand points. In one or two instances shafts were sunk in addition to the one holding the air-lift installations. This also materially increased the yield to the sump.

The greatest difficulty has been experienced in sinking the sumps on account of the very unstable quicksand. There seems to be no set formula for guarding against cave-ins around sumps, successful sinking being more a result of technique and knowledge of quicksand than anything else. The sumps or caissons are of wood. The most important requisite of their construction is that they be flexible. They are sunk in the usual manner by dredging from the inside, a feature of successful sinking being that the caisson must sink exactly as fast as the material comes out. Most of the sumps are 12 ft. in diameter. In addition to the combination wells, there was used a somewhat similar installation which pumps only from a surface sump by means of an air lift.

On the north side of the river a station is under con-

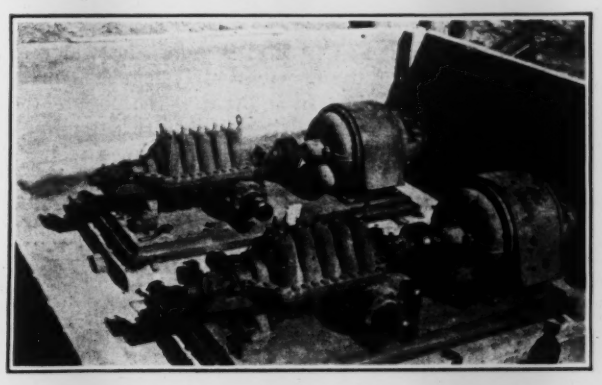


FIG. 9—FIVE-STAGE PUMPS USED AT WATER STATION

struction which will provide about 50,000 bbl. of soft water per 24 hr. It is planned to develop this supply by means of a tunneling method as illustrated diagrammatically in Fig. 5. The plan is to sink an open top wood chamber 16 ft. square into the bed of a sandy stream adjacent to one bank. A double row of wood sheetpiling will then be driven from this chamber across the bed of the stream to the opposite bank in such a manner that when roofed over with timber a tunnel 8 ft. wide will be formed below the water level. Dredging is also necessary to completely sink the tunnel. Sand points will then be inserted in the upstream wall of the tunnel and an extra large supply of water brought into the well.

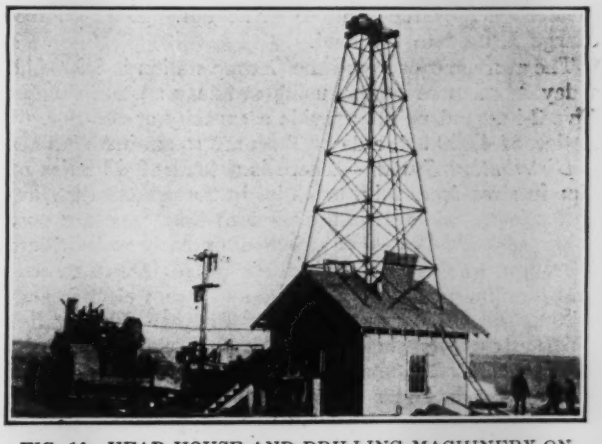


FIG. 10—HEAD HOUSE AND DRILLING MACHINERY ON DEEP DRILLED WELLS AT PLAINS STATION

Note—The well installation consists of a 100-hp. motor driving a vertical 15-stage deep well pump. In this illustration the drilling machinery is set for cleaning out the well after the pumps had sanded. Gas jetting was also used.

By tilting the ends of the sand points upward, the danger from clogging is minimized.

Pumping Stations—There are at present three main pumping stations that are of a rather permanent nature. These are indicated on the map, Fig. 1, as Dixon Creek station, Neil station, and the Plains station. Three other temporary stations are indicated as Big Creek, where the tunneling is being done, Sec. 61, and George.

Different equipment and well types were used at the different stations. The Dixon Creek station shown in Fig. 7 is supplied by two combination wells, one using one type of air lift, the other using the second type, and by six drilled wells, all operated by air lift. These wells pump into a concrete reservoir 65 ft. square and 5 ft. deep excavated in quicksand and designed for hydrostatic pressure inside and out. The five-stage, 600-g.p.m. pumps shown in Fig. 9 pump the water to the various points of the distribution system at a pressure of 250 lb. per sq.in. In addition to the pumps, the station contains two electric-driven 600-cu.ft. per minute compressors supplying air for operating the surrounding wells. At Neil station, there are 10 air-lift wells of type 1, Fig. 2, the average capacity being about 7,000 bbl. per well. The wells pump into a 1,600-bbl. wooden tank, from which four steam mud-hog pumps, 12x6¾x 14, pump into the distribution system. This type of pump is used since the sand, which is present in the water, becomes embedded in the rubber piston packing and thus does not score the cylinders as it would on ordinary piston pumps. Four portable air compressors, each with a capacity of 150 cu.ft. per minute, supply the air for the wells.

The Plains pumping station is located about 15 miles from the producing area. Three gravel wall wells, approximately 400 ft. deep, are now in and a fourth is being installed. Each well is pumped by a 15-stage centrifugal pump on a 3-in. vertical shaft hung in the well casing; and 100-hp. electric motors housed on the surface operate the pumps. Water is pumped from the wells into a 10,000-bbl. steel settling tank, from which it is pumped into the distribution system by three 5-stage motor operated centrifugal pumps, each having a capacity of 635 g.p.m. In the 10,000-bbl. steel storage tank the outlet is on the opposite side from the inlet in order to provide enough of a detention period for the greater part of the sand to settle out. A 12-in. discharge is used to the field.

The average capacity of the George station is 8,000 bbl. a day from three sumps, using ordinary suction pumps. Five 2-in. sand points provide a capacity at the Sec. 61 station of 4,000 bbl. a day. Both are steam-installations.

Distribution System—There is a total of 42 miles of pipe in sizes from 4 in. to 12 in. in the present distribution system, while 16 miles of 6 to 8-in. pipe are now being added. Water is supplied to each well-drilling operation, to the company's three 50,000,000-cu.ft. natural gasoline plants, to a 10,000-kw. steam electric generating station and to the city of Borger. Placing this pipe system over the very rough country was in itself a large construction and engineering problem. All of this system is under direct pressure from the pumps. However, each oil lease is usually provided with a 1,600-bbl. storage tank from which the water flows by gravity to the wells. Pressures on the main distribution system vary from 250 to 450 lb. per square inch.

It is expected that after four or five years all stations will be abandoned except the Plains station which will furnish sufficient water for the field. The lines in all probability will remain intact, although some of the largest sizes may be removed and smaller pipe substituted. The work is being done under the direction of A. W. Riney, construction superintendent, Paul Endacott, field engineer, and William Crites, superintendent of operation of the water system in the Panhandle field.

Wind Velocities in United States from Long-Time Records

A Compilation of Maximum Weather Bureau Records Corrected to True Wind Velocities As Guide to Designers

By P. K. Schuyler
U. S. Bureau of Public Roads, Washington, D. C.

THE designer of bridges, tall buildings, radio towers, chimneys, standpipes and signboards is called upon to exercise a rare degree of engineering judgment in selecting the proper wind velocity for which to design his structure. Records of wind velocities in the United States are in a more or less confused and unsatisfactory state, due both to the meagerness of the available records and to the differences in the rating of recording instruments. General ideas of wind velocities and pressures are correspondingly variable, as reflected, for example, in building code requirements for horizontal wind pressure—a pressure of 20 lb. per sq.ft. is prescribed among other cities by Atlanta, Boston, Evansville, Jackson, Miami, Richmond and Tacoma, while Pittsburgh and Omaha specify 25 lb., and Columbus, New Haven, New York and St. Paul specify 30 lb. This list indicates that building code requirements represent arbitrary assumptions rather than geographical differences in wind possibilities. Some of the cities in regions where high wind velocities may be expected have lower requirements than cities in regions of lower wind velocities.

Records collected by the U. S. Weather Bureau are compiled, with corrections, in Fig. 1. The figures given are maximum recorded wind velocities over a 5-min. period, corrected for the anemometer error so as to show true wind velocity. It will be seen that they vary over a wide range. These records, however, are not a precise indication of the maximum velocities that may occur in a given locality, because in many instances the recording instrument is situated in a sheltered location, while in other instances the records cover only a short period of years, during which interval there were no violent storms.

The records compiled in Fig. 2 represent the action of storms covering large areas, technically known as tornadoes. Tornadoes are local storms of quite different character, affecting only a narrow strip of territory, usually not more than 100 yd. or so wide. Tornado velocities also must be considered in structural design, but unfortunately there are no records of velocities available, partly because of the local character of the storm and partly because buildings and instruments are usually carried away in tornadoes. The probability of a tornado striking a particular structure is usually so small that it can be neglected. In certain sections of the country, however, these storms are more prevalent than in others, and designs for such regions should give some consideration to tornado possibilities. As an aid to this, the map Fig. 2 is given, showing the geographical distribution of tornadoes in the Eastern United States over a period of 87 years.

It will be seen that the region in which the greatest number of tornadoes has occurred comprises Eastern Kansas, Missouri, and Illinois. Structures in this part of the country doubtless should be designed with some

consideration to the tornado risk. But, as previously stated, data as to the velocities produced in tornadoes are entirely lacking, and the designer must depend upon his judgment in proportioning a structure in the tornado belt.

Determination of designed wind pressures has many other complications, and calls for careful weighing of the conditions of service of the structure under consideration. For example, in the case of telephone and power lines it may be economical to rebuild occasionally rather than to design for maximum velocities. In the case of bridges and buildings, however, human lives are at stake, and such structures must be made reasonably secure against destruction. In each individual case, all data bearing on the future life of a structure should be collected, and all the factors involved given consideration. It is hoped that the figures given in this article may serve as a data which will aid the designer in his work.

FIG. 1—MAXIMUM WIND VELOCITIES IN THE UNITED STATES

Data furnished by U. S. Weather Bureau. Figures represent maximum observed velocities at the respective stations, in miles per hour, corrected for anemometer error so as to represent true wind velocities.

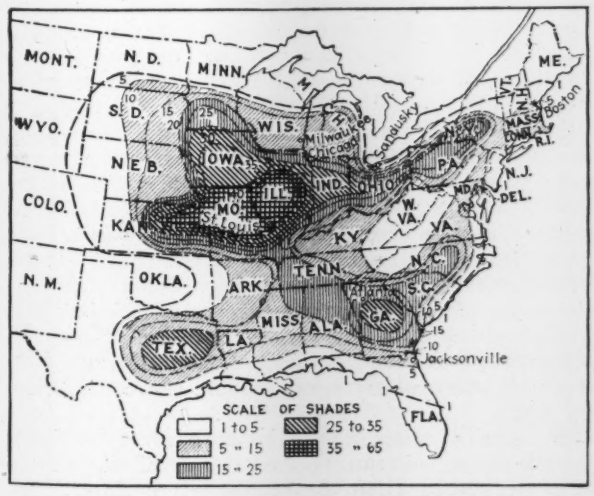


FIG. 2—DISTRIBUTION OF TORNADOES

From a map prepared by Col. J. P. Finley. Tornado velocities are not included in the figures given in the map Fig. 1.

Data on Hollow and Solid Brick Walls

Hollow brick walls for residences are strong enough to meet building code requirements and are cheaper to construct than solid walls, since they make possible a saving in brick, mortar, and time, says the Bureau of Standards, Department of Commerce, following a cooperative study with the Common Brick Manufacturers Association of America on the compressive strength of brick masonry. This investigation included tests on 159 brick walls, each 6 ft. long and 9 ft. high. The proportioning of the materials used for the mortar was carefully supervised, and records were kept of the quantity of material used and the time required to build each wall. The solid walls were built in the common American bond having headers every sixth course. The hollow walls were of the various types described in the publication of the Common Brick Manufacturers Association "Hollow Walls of Brick and How to Build Them."

Design of Ice-Breaker Pier Nose For Missouri River Bridges

Thickness and Action of Solid Ice—Splitting of Ice Cakes—Pressures on Piers—Mush Ice and Ice Gorges

By J. E. Kirkham
Bridge Engineer, South Dakota Highway Commission

FOR the piers of the five new Missouri River highway bridges built recently by the state of South Dakota, a vertical blunt-edged nose was adopted on the upstream face, as shown by the description of these bridges in *Engineering News-Record,* May 5, 1927, p. 736. A typical pier is illustrated in Fig. 1. At all these bridges the upstream nose of each pier has the form shown in Fig. 2. It is finished with an 8x8-in. angle anchored to the concrete and extending from 18 to 36 in. below low water and to about 2 ft. above high water.

In the design of this form of nose, careful study was given to the problem of ice action. The ice is usually 2 to 3 ft. thick, but as a rule only about 2 ft. is really solid ice, the upper part consisting mainly of snow layers which are melted by chinook winds at intervals and then frozen into comparatively brittle ice. During the winter the ice will rise and fall as much as 3 to 4 ft. with the varying stages of water, and this continual movement causes it to crack more or less. In the spring, when the ice goes out, it will rise from 5 to 8 ft. and start down the river. At such time there is a stretch of open water on each side of the river, into which the ice will flow, causing cracks to widen in the main channel so that when the ice starts to move the largest cakes will be about 100 ft. square. This is the ice that had to be considered in designing the piers.

Cake and Mush Ice—Tests on the strength of ice in tension were carried out by breaking ice briquets in a cement testing machine. Some of the briquets were allowed to remain out over night in very cold weather and were broken early in the morning; others were broken at different times in the day. The effects of temperature on tensile strength were thus obtained. It was found that the maximum strength of ice in tension was about 100 lb. per sq.in. The writer had these tests made with the idea that it was more feasible to break thick ice in tension than by crushing. As a result of these tests, the vertical ice-breaker nose was used.

It is obvious that the sharper the nose the less will be the pressure exerted on the pier by the ice, but other features of the action deserve consideration. The greatest wear on the nose and sides of the pier is due to mush ice or comparatively light ice which will run in the river for weeks at a time. This mush ice has cut through ordinary wood piling in five to six hours. The writer's idea was to make the nose of the pier sufficiently blunt to bank up the water to such an extent that mush ice would be carried around the pier without touching it. This action was obtained by making the bevel of the nose 45 deg. with the longitudinal axis of the pier; at the same time the nose was sufficiently sharp for cracking the solid ice in tension.

Ice Action on the Pier Nose—To show the action of flowing ice on the nose of the pier, let *A B*, in Fig. 2, represent a cake striking the pier at *C*. This nose being sharp, a high pressure equal to the maximum crushing value of ice will be exerted at the beginning of contact, but the area of contact is then so small that the pressure is of little consequence. Suppose the nose cuts into the ice for 10 in., then the pressure against its sides will be perpendicular as indicated. When this pressure is 10 lb. per sq.in., the component transversely will produce a tension of 100 lb. perpendicular to the longitudinal axis of the pier causing the crack *C D* in the ice. In other words the ice cake will be split in two, when the longitudinal pressure on the pier is about 2,200 lb. per foot of thickness of ice. This means that if the ice were 2 ft. thick, the longitudinal pressure on the pier would be only about 4,400 lb., which is practically negligible. If the point of contact were at the center of a cake of ice 100 ft. square, a pressure against the sides of the nose of the pier would be required to move the two half cakes around the pier. Assuming that the two half cakes were forced out simultaneously, the weight of each half, if a foot thick, would be about 300,000 lb. The writer has computed that the average acceleration of this mass would be about 2 ft. per second per second, which would require a force of about 18,000 lb. acting perpendicularly to each side of the nose of the pier.

Resolving these two forces along the longitudinal axis of the pier, we obtain a pressure of 26,000 lb. per foot of thickness of ice tending to overturn the pier. The force at this time required to crack the ice is not acting. Then, if the ice is 2 ft. thick, we have a force of 52,000 lb. acting against the pier to turn these two cakes around the pier. But the writer has observed that the banking of the water in front of the pier causes an upper current that aids greatly in turning large cakes of ice around the pier and hence even this computed pressure does not occur.

It is evident from the above that the pressure against the pier required to split or crack the ice is of quite low intensity, regardless of the thickness of the ice. For instance, if the ice were 10 ft. thick, which is about four times any thickness that ever occurs on the Missouri River, the pressure against the pier tending to overturn it would be only 22,000 lb. The heaviest pressure, no doubt, comes from the turning of the ice cakes around the piers. But we have considered cakes 100x50 ft., which are considerably larger than the average cakes in the flowing ice. Cakes of this size will not pile up on top of each other, and consequently, the 26,000 lb. pressure per foot of depth would not extend constantly down into the water to a depth of 10 ft. even in an ice gorge.

Ice Gorges—To analyze the action of ice gorges, it is necessary to consider how their pressure can occur and also the depth of water, as gorges are due practically always to the water not being of sufficient depth to carry the ice accumulation. In other words, most ice gorges extend to the bottom of the river, and the friction against the bottom is so great that the ice cannot move. If the ice is gorged across the river and bearing against each pier, the only pressure of any consequence against the pier would be due to the difference of the elevation of the water surface above and below the gorge.

The depth of water in the Missouri River across South Dakota during extreme floods is about 25 ft. If the ice were gorged from the bottom of the river, only about 3 ft. of ice would project above the downstream surface of the water, giving a water pressure against the

ice gorge of about 280 lb. per lineal foot across its crest. If the bridge spans were 300 ft. and each pier took full pressure, it would amount only to about 84,000 lb. per pier. If the ice gorge were held fast to the bottom of the river by friction, even this pressure would not exist.

If the ice gorge were floated and started to move, the cakes of ice in the gorge would become loose and the pier would cut through at a much lower pressure than 2,200 lb. per foot of depth, as the cakes of ice in gorges are comparatively small and would move very readily when coming in contact with the vertical sharp nose of the pier. Then the center of pressure would be much lower than would be considered in the case of free flowing ice, which would lower the overturning action on the pier. Assuming that the ice pack is 20 ft. deep

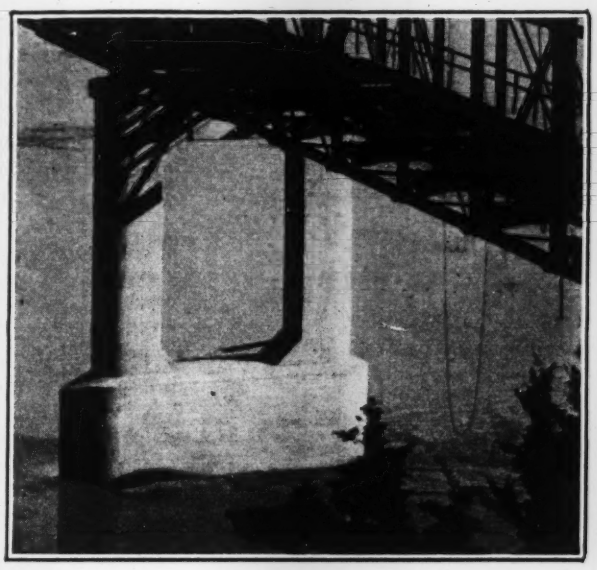


FIG. 1—BRIDGE PIER WITH VERTICAL ICE-BREAKER NOSE
Note wave at shoulder of pier. Current flows to the right.

(and it could not float on the Missouri River if it were any deeper) a total pressure against the pier, due to the gorge moving around it, would be about 130,000 lb. tending to overturn the pier. But the resultant of this pressure would be considerably lower than assumed in the case of ordinary flowing ice, which of course reduces the overturning moment on the pier.

Pressures against Piers—The writer found that the greatest pressure tending to overturn the pier was when the pier was frozen in and the ice would rise 8 ft. and start down the river. Assuming solid ice 2 ft. thick, it would require a pressure of about 2 lb. per sq.in. on each side of the nose to split the ice. But to allow the ice to pass by the pier, he considered that the ice would crush against the sides of the nose and on the round shoulders. In that case, the round shoulders are very efficient for crushing the ice, as the slope is flat and very little pressure along the axis of the pier is exerted in comparison with the pressure perpendicular to the curve. It was found from calculations that the pressure was about 360,000 lb. in the direction of the longitudinal axis of the pier, which is greater than the piers are actually subjected to. This idea is based upon observation of ice runs during the last three years. In designing the piers, however, the writer took twice this pressure, or 720,000 lb., as the maximum ice pressure applied at a point 3 ft. below high water.

Two years ago, the ice at the Mobridge bridge rose about 7 ft. and started down the river, apparently intact, as the writer assumed in his calculations. The cracks in front of each pier extended in a straight line up the river for several hundred feet, also as he had assumed. But the crushing against the nose of the piers did not occur as he had assumed it would. Instead, the ice seemed to flow around the pier and to close up and go down the river without any grinding action. Evidently the pressure of 360,000 lb. is higher than is ever exerted.

Obstructions in Ice—The writer considered the cutting of logs frozen into the ice, and other obstructions that might hit the piers, but in each case the obstruction would fail in cross-bending and shear combined without exerting a very great pressure on the piers. Last year the railroad bridge just above the Chamberlain highway bridge was washed out, fell on its side and was washed against the piers of the latter. These piers cut the steel rails and track in two, without even jarring the piers. Evidently in that case the rails were broken more in cross-bending than in shear.

Although ice of the highest tensile strength has been considered, the fact is that thick ice on the Missouri River flows only when the weather has been quite warm for some time, the strength of the ice being then much below maximum by the time it flows.

Other Forms of Ice Breakers—The type of ice-breaker here discussed may not be best in all cases, but apparently it is the best for ice running in comparatively large cakes as on the Missouri River in South Dakota. In the Cheyenne River, where the ice is broken up into comparatively small cakes and the current is exceptionally swift, the writer has used piers having vertical rounded noses, as under such conditions it is better to have a nose upon which the ice can roll.

Where the ice is very thick and moves in a continuous sheet, the writer would use a flat inclined nose. The inclined nose is objectionable in some cases on account of the accumulation of drift upon it; flat inclined noses may cause ice jams due to this accumulation of drift and ice. The idea that a flat inclined nose is preferable

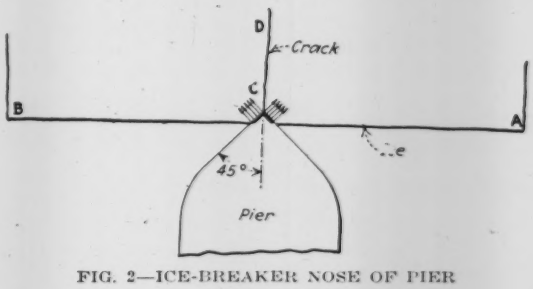


FIG. 2—ICE-BREAKER NOSE OF PIER

on account of the resultant of the ice pressure being downwardly inclined, is questionable. The writer has observed that large cakes of ice running up on such an inclined nose and striking the pier produce a resultant pressure which is inclined upward instead of downward. In such cases, a vertical nose is preferable. No fixed type of nose in detail can be specified as being the best for all cases. The type and detail must be governed by the local conditions.

Six-Story Addition to Building Independent of Old Frame

New Columns Carry Loads 175 Ft. to Ground—Method of Construction Used Did Not Disturb Tenants of Old Building

By David Gutman
Consulting Engineer, New York City

THE ADDITION of six stories to an office building in New York City of the steel skeleton type built in 1912 has been satisfactorily completed by using as supports a new set of columns carried to the ground. The loads of the new addition are therefore supported independently of the old frame except in so far as the wind bracing used at each floor causes the frame to act as an integral unit.

The original building, consisting of 12 stories and a roof about 175 ft. above the sub-basement, was not designed to carry any additional stories, although the live-load used in the original design was greater than that required by the present law for an office building. The first plan considered was based on this excess of live-load and provided for strengthening the existing columns down to about the fourth floor by encasing them in reinforced concrete. Although this method was practical from an engineering point of view, it involved stripping the old columns which would have greatly inconvenienced the tenants. It was therefore abandoned.

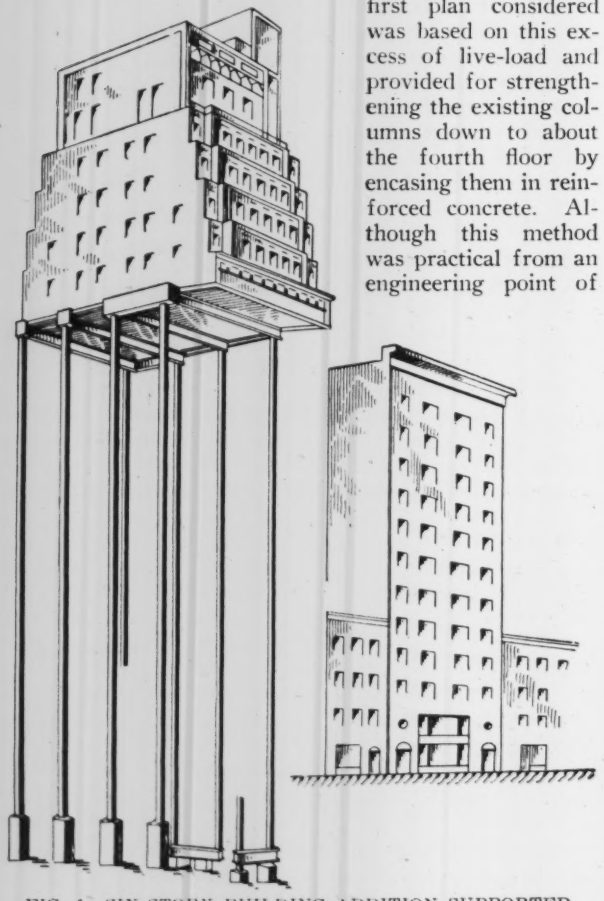


FIG. 1—SIX-STORY BUILDING ADDITION SUPPORTED ON STILTS

The plan finally adopted provided supports for the new work independent of the old structure. Eight new columns were added, four along the east lot line and four at the west lot line. On the east side the new columns were placed as close as possible to the old columns and in stair wells or elevator or utility shafts. It was possible to place the west side columns directly opposite the old columns and on the outside of the old wall, since the owner had title to the adjacent 25 ft. of property on which he was erecting a two-story building. Interference with the tenants was therefore reduced to a minimum.

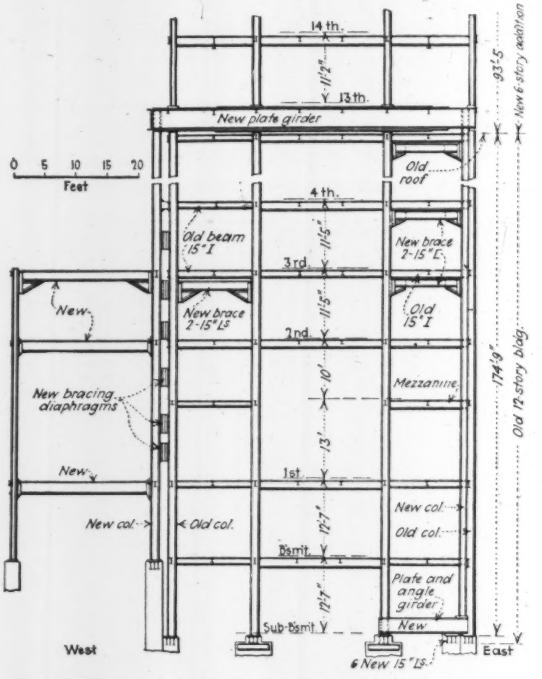


FIG. 2—STRUCTURAL FRAMEWORK SHOWING SIX-STORY ADDITION SUPPORTED ON INDEPENDENT COLUMNS

The plan then consisted of erecting four new columns on each of the long sides of the building running to the roof of the old building and tying them together across the top by heavy plate girders having a 50-ft. span. The effect, as regards the added stories, is somewhat analogous to a building supported on stilts. The new columns were braced in both directions either by adding new braces or by a connection between the new columns and the old columns or old spandrel beams. Also, since the old building had not been braced to take wind stresses for an 18-story structure, it was stiffened at the third floor by the braces shown in Fig. 2. The new two-story building added on the west also had a stiffening effect on the new structure.

The footings on the west line presented no difficulties, being the usual type of grillage resting on rock. The footings on the east were more of a problem since the new columns practically touched the old and were in fact over the old footings. Here it was necessary to use a cantilever grillage plan.

The new pent house was built over the old and the elevator machinery moved to the higher levels, one machine at a time, for at no time was service discontinued.

The building is located at 9 East 40th St., New York City. The author was consulting engineer. The architect was Nathan Korn; the general contractor was H. R. H. Construction Co.; and the steel contractor, Taylor-Fichter Co., all of New York City.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Air Attacks on Large Bridges

Sir—The great Hudson River bridge, described in *Engineering News-Record*, Aug. 11, 1927, p. 212, leads to a thought which perhaps has not been considered in the planning of this greatest of structures. It is this: What means are to be taken in time of war to guard such a structure from aerial attack by enemy planes?

Here is a target almost a mile long and more than 126 ft. wide, a bridge involving an ultimate expenditure of $75,000,000, forming a connecting link between New York City and the mainland, which is of such enormous proportions that it makes an easy target for and which may be completely destroyed by a single aerial bomb. The moral effect of the destruction of such a bridge during war time would be calamitous. The defense from aerial attack of such a large object therefore will present a real problem as the airplane is developed into a more serviceable and more reliable weapon. The recent trans-Atlantic flights have amply demonstrated what may be expected from the airplane in another decade or two. It will be entirely possible for hostile planes to operate not from so-called mother ships, but from their regular land bases across the sea, enabling them to leave for their objective in secret, timing their arrival when observance would be most difficult. Furthermore, as the airplane is improved and developed, its offensive arms will also be improved and developed so that hits which today are difficult to make will be far less so as time goes on.

Great bridges, because of the large expenditures and engineering difficulties involved, are called into being only when there is great need of them. Their destruction by an enemy in time of war would be a great disaster. Therefore their planning must involve not only those items which relate to design, economy, and operation but also the important item of protection from aerial attack during war.

Providence, R. I., August 23, 1927. ELI M. VINER, Consulting Engineer.

Standard Sections for Street-Car Rails

Sir—Referring to abstract of Mr. Catherman's paper on track construction which appeared in *Engineering News-Record* of July 21, p. 102, I feel that in view of your use of this article, the opportunity should not be lost of presenting to your readers the facts regarding the degree to which the official association of the electric railway industry has advanced in the matter of rail standardization, mainly through the work of its engineering association Committee on Way and Structures.

There are now two sections of grooved girder rail (one 7 and one 9 in. in height) weighing 122 and 134 lb. per yard, which have been standard since 1913. In addition there will be recommended for adoption as standard this year an existing lighter 7-in. grooved girder rail weighing 103 lb. per yard, which will meet the requirements of the smaller properties with lighter rolling stock and less frequent service. In connection with the subject of grooved girder rails, it might be mentioned that the use of the A.E.R.E.A. 7-in. standard sections has now reached the point where they comprise more than half the total rolling of one of the two manufacturers of such rails in the United States and more than three-quarters that of the other. Both these rail sections are also American standard.

There are also three sections of 7-in. plain girder rails, or so-called high tee-rails, weighing 82, 92, and 102 lb. per yard respectively, which have been standardized by the A.E.R.E.A., and are also American standards. The Electric Railway Association has also adopted as recommended designs three sections of so-called standard tee-rails, i.e., the 80-lb. A.S.C.E. and the 90 and the 100-lb. A.R.A. A-rails.

This gives a total of eight sections which have been standardized by committees of the electric railway industry. The fact that all five sections which have been essentially designed to meet street railway conditions have been adopted as American standards speaks for itself. It is felt that there is no condition of traffic on any street railway system which cannot be satisfactorily met by one or another of the above eight rail sections. The trouble has been to persuade the individual engineer to "see his problem as others see it."

We should not lose sight of the fact that the rail manufacturer is in business for the same ultimate purpose as any other firm—to make money. While it is reasonably certain that he would very much prefer to have only a few rail sections to roll and that he does discourage the rolling of obsolete sections and the development of new sections unless he is assured that the latter will replace existing sections, it must be remembered that he generally does so reluctantly and only after the purchaser has agreed to pay the extra manufacturing costs involved in getting out new rolls, this being the premium for meeting the ideas of the individual.

If the truth were known, it would probably be found that the blame for the situation which exists lies entirely with the engineer. It could not be expected that the manufacturer would refuse to accept such business if it can be secured on terms which will assure him a profit. If more use were made by the engineers of today of the past experiences of their predecessors, the cause of standardization would be much further advanced than it now is, and this does not mean that all further development of a given product or process should cease. However, it is a situation and not a theory which we have to face and as long as men continue to be so constituted that they can only see things their own way, just so long will we be up against the "57 varieties," not only in the rail manufacturing industry but in many other fields as well.

Mr. Catherman must admit, however, that the girder rail situation shows a marked improvement over that which existed 15 or 20 years ago, as regards the number of rail sections available.

Newark, N. J., July 29, 1927. HOWARD H. GEORGE, Chairman, Committee on Way and Structures, American Electric Railway Engineering Association.

Rail Clips for Cranes

Sir—On p. 235 of your Aug. 11 issue you show a simple method of attaching crane rails to I-beams. The accompanying sketches show three other methods of attaching crane rails to supporting I-beams, two of the methods not requiring any drilling in the rails. In Fig. 1 clips are used in pairs and require no drilling either in the rail or in the supporting beam. In Fig. 2 clips are used in pairs right and left, two holes 3 in. apart being drilled in the web of the rail for each pair of clips. Fig 3 shows clips for use on wood supporting beams.

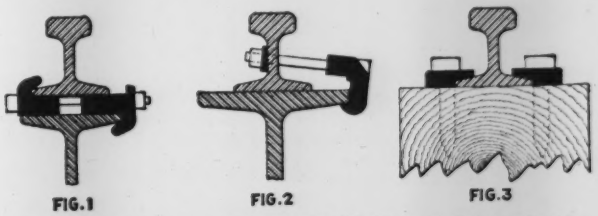


FIG. 1 FIG. 2 FIG. 3

METHODS OF ATTACHING CRANE RAILS TO I-BEAMS

D. E. PARRISH, Treasurer, Herbert Morris, Inc.

Buffalo, N. Y., Aug. 22, 1927.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Chicago's Water Meter Plan Checked

Abandonment of Meters Favored But War Department Opposes Any Modification

By a vote of 8 to 6, with 4 members absent, the finance committee of the city council of Chicago reported favorably, Aug. 24, on Mayor Thompson's plan to substitute water waste survey and plumbing inspection for the program of universal metering on which the War Department conditioned its permit for the diversion of water from Lake Michigan to the Chicago drainage canal. The council deferred action on the plan.

The details of the plan as first announced (*Engineering News-Record*, Aug. 18, 1927, p. 263) have been changed so as to put the office work under a superintendent and an assistant superintendent of plumbing at $6,000 and $5,500 a year and various plumbing foremen, inspectors, etc., with a staff of laborers, instead of in the bureau of engineering under an engineer with engineering assistants.

Opposition to the abandonment of the metering plan, with general approval of pitometer and other waste-prevention surveys, was voiced before the finance committee on Aug. 22, by the public affairs committee of the Western Society of Engineers, through A. J. Hammond, chairman, with the approval of the board of direction of the society.

On Aug. 24, Brig.-Gen. Herbert Deakyne, assistant chief of engineers, U. S. A., wired as follows to Mayor Thompson's attorney in charge of promoting the substitute plan:

"I have noticed published statements quoting you to the effect that the War Department would take no action if the water metering ordinance should be modified by the city of Chicago and giving me as authority. You will recall my statement that I could not speak with authority as to what action the War Department would take in such a case. Immediate action is contemplated, in case the metering program specified in the permit is modified without authority of the Department."

U. S. Represented at Conference on Communication and Transit

Julius H. Parmelee, director of the Bureau of Railway Economics, Washington, D. C., is representing the International Chamber of Commerce at the third general conference on communications and transit now being held at Geneva under the direction of the League of Nations. The United States Government is represented at the conference by Hugh R. Wilson, American Minister to Switzerland, with Chauncy G. Parker, counsel for the U. S. Shipping Board, Norman F. Titus, chief of the Transportation Division of the Department of Commerce, and William H. Bonneville, of the Interstate Commerce Commission, as his technical advisers. The conference, it is understood, will not draw up international conventions, but will consider a plan for the collection and exchange of information in regard to communications and transit.

Engineering Fifty Years Ago

From *Engineering News*, Sept. 1, 1877

STEAM street cars commenced running successfully on the 21st ult. in Brooklyn, N. Y.

* * *

The Cream City Street R.R. company of Milwaukee will soon receive a Baldwin steam car.

* * *

The new Edison telephone was tested last Saturday at the Western Union Building in New York, over the extraordinary distance of 240 miles. The wire used was a loop to Hartford, Conn., and back, over which music was transmitted distinctly.

* * *

The Boston *Daily Advertiser* says; "The water board has found that the old-fashioned cast-iron pipes are more serviceable in the long run than the patent pipes composed of sheet-iron and cement, which were laid down at the time of the introduction of the Mystic water, and these accordingly are being replaced with the old style."

Begin Survey Work to New Port for Hudson Bay Railway

To speed up the work of surveying the territory through which the Hudson Bay Ry. will pass from the end of present steel to the proposed terminal at Port Churchill, three engineers from the Dominion Department of Public Works at Ottawa, accompanied by a small party of special craftsmen, have gone north to the Pas, Manitoba. About 200 more men will be engaged. Some of the party will proceed to Port Nelson to commence the work of retrieving as much of the harbor material as can be used at Port Churchill.

Buffalo Votes to Abandon Commission Plan

Returns to Mayor-and-Council Plan Party Primaries and Partial Separation of Powers

The proposed new charter for Buffalo, N. Y., substituting a mayor-and-council plan for the commission plan in use for eleven years past, was adopted by a vote of some 32,000 for to 21,000 against at a special election held Aug. 29. The charter was drafted by a commission of seven members "appointed pursuant to a local law" approved by a large popular majority in November, 1926. The total vote was about one-third of the registration. The main features of the new charter are:

A mayor, a comptroller and a council of 15 members, the latter including a president of the council, elected as such. Of the 15 councilmen, 6, including the president, are elected at large and 9 by three-ward districts. The 17 persons enumerated are the only elective officers. Save the district councilmen, all are elected at large for four years. No elective officer may succeed himself, except the comptroller and the district councilmen, the latter for a second two-year term only. Elective officers are nominated in party primaries, but there may be independent nominations, under the state election laws.

The principal executive and administrative departments of the city are: (1) Executive (budget, purchases, markets and licenses), (2) treasury, (3) audit and control, (4) assessment, (5) public works (engineering, buildings, streets, water), (6) parks (including recreation and airport divisions), (7) police, (8) fire, (9) health, (10) special welfare and (11) law. All these are single headed, except assessment, health and welfare which are administered by boards, but there is an advisory airport board.

Department heads and multi-heads (boards and commissions) are appointed by the mayor except that the board of assessors is appointed by a board composed of the mayor, president of council and comptroller, or a majority of the three. All these appointments are subject to approval by the council, but the mayor has sole power of removal of his appointees and the heads appointed by the board of three are subject to removal by that board. The mayor, president of council and comptroller may be removed by the governor of the state, in the same way as sheriffs may be removed under the state constitution.

Deputy commissioners and other bureau or division chiefs are appointed by their respective department heads or

boards and are removable by them at pleasure, but no classified civil service employee subject to examination shall be removed except after written charges and trial "for incompetency, misconduct or insubordination," the trial to be by the mayor, comptroller and president of the council, except in case of officers and members of the fire and police department, when trial shall be by the respective commissioners, or by the board just named if the accused so elect.

FIRE DESTROYS FALSEWORK OF PITTSBURGH BRIDGE

The charter declares that legislative and executive powers are separate, with the mayor the chief executive and administrative officer. But the mayor has a limited veto power over legislation and the council can block the mayor's appointments by refusing confirmation (unless it be members of the civil service commission). As regards the board of assessors, the mayor shares his power of appointment with the president of the council (elected as a legislative official) and the comptroller. Sole power of removal of department heads appointed by the mayor and confirmed by the council rests with the mayor but in the removal of civil service employees (on charges), the mayor shares with two other elected officials, as already stated. Lower down in the executive scale, the charter provides that if the commissioner of public works declines to add to the general paving specifications kept on file in his office, specifications differing therefrom offered by actual or prospective paving contractors, an appeal can be made to the council and it can override the commissioner. Again, the president of the council exercises both legislative and executive functions in that he is a member of the board of review of contract awards (with the mayor and comptroller) to which "any person conceiving himself aggrieved may appeal" from any contract award.

Appointments made by the mayor, subject to confirmation by the council, are: Directors of budget, law, purchase, license, markets; commissioners of public works, police, fire; boards of health and of social welfare, each of five members. Appointments shared by the mayor with the president of the council and the comptroller are the three members of the board of assessors.

The commissioner of public works (like the other department heads) appoints his division officers, each of whom is also deputy commissioner of works. These are: City engineer and director of buildings, water, streets. Except the latter, the evident intent of the charter

REMAINING PORTION OF ARCH RIBS AFTER THE FIRE

s that these directors must be civil engineers, but the printed copies in circulation specify professional qualifications for the city engineer and director of buildings only, each of whom must have had six years of actual practice in his profession, with responsible charge of work as principal or assistant for one year. The only other officials for whom qualifications are prescribed are members of the board of health, the commissioner of health and his bureau heads.

The charter becomes effective Jan. 1, 1928, but the present mayor, Frank Schwab, remains in office until the expiration of his term, in 1929.

Pittsburgh Bridge Damaged By Fire in Formwork

Fire which broke out in the formwork of the new Mount Washington roadway bridge over the Castle Shannon inclined railway in Pittsburgh on Saturday afternoon, Aug. 27, resulted in the complete destruction of the greater part of the formwork and falsework for the two concrete arch ribs and the loss of most of the reinforced concrete already in place.

As shown in the accompanying illustration, the major part of the concrete in the ribs had been poured and it was planned to start pouring the key blocks on Monday. The fire started near one end of the formwork where a workman was using a welding outfit and spread rapidly. On account of the inaccessibility of the site it had gained considerable headway before the city fire department could do any effective work and inside of 20 min. one rib had fallen. The other rib fell soon afterwards.

The arch has a span of 208 ft. and a height of 90 ft. The arch ribs are 5 ft. 6 in. by 5 ft. and the sections which had been poured were in blocks 30 ft. long. It is of interest to note that although of comparatively green concrete, none of these blocks were broken except those which fell across other blocks.

The work was being done by the Vang Construction Co. under the direction of the Department of Public Works of the city of Pittsburgh. The loss is estimated at from $75,000 to $100,000 and delays completion of the bridge.

Operation of the Castle Shannon incline railway was stopped as soon as the fire was discovered. Falling embers set fire to the railway structure during the early stages of the fire and subsequently falling concrete destroyed the rails and damaged the cables. The estimated damage is placed at $2,500.

The accompanying photographs show, above, the bridge after one of the arch ribs had collapsed, and below, after both ribs had fallen. The incline railway passed through the opening at the left of the falsework in the upper picture.

St. Paul to Vote on Relieving Street Railway from Paving

The city of St. Paul, Minn., will vote on Sept. 6 on an amendment to the city charter making it possible for the city council to relieve the St. Paul City Railway Co. from paving between its tracks and providing $200,000 per year for the years 1928 to 1931, inclusive, to cover the cost of such paving work. The city also will vote on a charter amendment to increase the percentage for engineering inspection which can be collected on investigations for local improvements from 2 per cent to 4 per cent.

Bond issues which will be put before the voters of St. Paul include $875,000 for parks and park buildings, $850,000 for land and buildings for the several bureaus of the Department of Public Safety, and for etxending the police and fire systems, $1,200,000 for enlargement and improving the public auditorium, $600,000 for a workhouse and workhouse farm and buildings, and $400,000 for an office building for the city offices.

Increased Interest in Engineering at College in Turkey

Increased interest in engineering subjects in Turkey is shown in the statement in the 64th annual report of Robert College, Constantinople, that 113 students were enrolled this past year in the four engineering courses and 61 in the shorter industrial course requiring two years. Graduates of the college are in considerable demand in Turkey. The course in electrical engineering has the argest number of students, owing partly to the interest of the Turkish Government which is paying the expense of 25 students in the engineering college, the majority of whom are to be electrical engineers. The enrollment during the past year was as follows: Civil engineers, 23; electrical, 43; mechanical, 25; preparatory, 22.

Five Flood Control Jobs Under Way in Los Angeles County

In addition to the $25,000,000 San Gabriel Dam project proposed by the Los Angeles County Flood Control District and which is now involved in controversy as to size of the dam to be built, five other construction jobs on the flood control program are now under way or just completed. These projects are listed in the accompanying table.

CONSTRUCTION PROJECTS OF LOS ANGELES COUNTY FLOOD CONTROL DISTRICT

Projects	Structure	Present Status	Estimated Total Cost	Contractor
Pacoima Dam	Concrete arch 385 ft. high 225,000 cu.yd.	60% completed. To be finished May, 1928.	$1,720,000	Bent Bros.
Sawpit Dam.	Concrete arch 155 ft. high.	June 13, 1927. Completed and accepted.	500,000	Heller Construction Co.
Puddingstone Dam.	570,000 cu.yd. earth fill, up-stream slope faced 140 ft. high.	Contract awarded July 18, 1927.	570,000	H. W. Rohl.
Puddingstone Diversion Channel.	Reinforced concrete flume, 14,000 ft. long; 100,000 cu.yd. excav.	Contract awarded July 18, 1927.	380,000	John C. Gist.
Puddingstone Diverson Dam.	70,000 cu.yd. gravel and sand fill, upstream slope concrete faced 32 ft. high.	Contract awarded July 22, 1927.	160,000	A. O. Nelson.

More Funds for California Road Work During Next 12 Years

Two new laws that will materially affect highway construction in California became effective on July 29 last. These are the 1c. additional gasoline tax and a new allocation of funds for highway construction and maintenance. The 2c. gasoline tax that has been in effect for some time has been bringing in about $18,000,000 per annum. With the normal increase in motor vehicles this is expected to increase to an average of $20,000,000 annually during the next 12 years. The additional 1c. tax, making the total now 3c. per gallon, is therefore estimated to average $30,000,000 per annum during the 12-yr. period for which the law is to be effective.

Funds from the 3c. tax are to be divided into three equal parts: one to be used for construction of new state highways, one for maintenance and repair of existing highways and the third to go into the general road fund of the 58 counties. The amount to each county will be proportional to the motor vehicle registration in that county.

Funds collected by the Motor Vehicle Registration Bureau plus the increased weight tax fees will total, it is estimated, about $8,000,000 per annum. This money will go into the road fund available for maintenance and reconstruction.

Ohio Makes Railway Grade Crossing Elimination Plans

As a result of the action of the Ohio State Legislature at its recent session, the State Highway Department is formulating a program for the elimination of dangerous crossings throughout the state. The legislature provided that out of the gasoline tax funds assigned to the Highway Department $1,000,000 per year could be used in eliminating grade crossings. As the law provides that the cost of grade crossing elimination be divided equally between the railroad companies and the public and as one-half the public fund is to be drawn from county sources, the state's contribution of $1,000,000 makes it possible to spend $4,000,000 each year. The director of the Highway Department is receiving applications from counties wishing to cooperate with the state in this work and expects to have the full $4,000,000 obligated before the end of 1928. This means that about 40 dangerous grade crossings can be eliminated.

War Department Perfecting Its Flood Control Plans

In order to co-ordinate the work of the various units now working on flood-control plans, Brig.-Gen. Herbert Deakyne, assistant chief of engineers, has been in St. Louis conferring with the president of the Mississippi River Commission, Colonel Potter, and Col. W. P. Wooten, president of the spillway board has been in Washington conferring with General Jadwin the Chief of Engineers. General Jadwin, has directed the spillway board to make further studies and computations and to include in its report additional data and a recommendation of the means to be employed for the control of a flood even greater than has heretofore been considered by the spillway board.

Senator Harris from Georgia has asked that the appropriate committees of the Senate and House be called together prior to the convening of Congress.

More Plans to Draw Water from the Colorado River

At a meeting of the Colorado Aqueduct Association held in Ontario, Calif., on Aug. 6, 1927, it was proposed to form a Metropolitan Water District that would include Los Angeles, Passadena, Long Beach, Whittier, Santa Monica, Beverly Hills, Hollywood, Burbank, Glendale, San Fernando, Altadena, Monrovia, Covina, Azusa, Duarte, San Dimas, San Gabriel, Riverside, Redlands, San Bernardino, Upland and any other cities that wished to join. The district if formed would build an aqueduct from the Colorado River into the area to be served and sell water wholesale to the various cities or to private water companies. The cost of this project is estimated at $250,000,000.

Eighteen of the cities interested sent delegates to the meeting with authority to contribute to the preliminary expense of forming the district.

Members of International Water Commission Named

The American Section of the International Water Commission, United States and Mexico, is in receipt of official information from Mexico, transmitted to the State Department, to the effect that Gustavo P. Serrano; Xaviar Sanchez Mejorada, and Federico Ramos have been named as the Mexican members of the International Water Commission.

Mr. Serrano is the Mexican Commissioner of the International Boundary Commission, United States and Mexico; Mr. Sanchez is an engineer and a member of the Mexican National Irrigation Commission. Mr. Ramos is a lawyer who has been acting as a general adviser to the Mexican Department of Foreign Relations.

Dr. Elwood Mead is the chairman of the American Section of the Commission.

Personal Notes

DUFF A. ABRAMS, director of the Department of Research, International Cement Corporation, is in Europe attending the 50th anniversary of the Association of German Portland Cement Manufacturers, held in Berlin, Aug. 28-31. He is the official delegate of the Portland Cement Association. Subsequently, Mr. Abrams will attend the International Congress of Testing Materials to be held in Amsterdam Sept. 12-17, where he will be the official delegate of the American Concrete Institute, of which he is vice-president. Mr. Abrams expects to remain in Europe for three months studying cement manufacturing processes abroad.

F. W. ALEXANDER, district engineer, British Columbia district, Canadian Pacific Ry., is promoted to be engineer, maintenance-of-way, western lines, Canadian Pacific Ry. Co., with offices at Winnipeg, Man., succeeding FRANK LEE. The position to which Mr. Lee is to be appointed has not been announced. Mr. Alexander entered the service of the Canadian Pacific Railway Co. as transitman at Moose Jaw in May, 1903, was appointed assistant division engineer at Calgary in July, 1910, and division engineer in April, 1915. On Jan. 1, 1917, he was appointed district engineer of the Alberta district, becoming district engineer at British Columbia, March 1, 1923.

FREDERICK SNARE, SR., president of the Frederick Snare Corp., contracting engineers, New York, N. Y., has been elected chairman of the board of directors of the corporation. ARTHUR W. BUTTENHEIM, formerly senior vice-president, has been elected president. EDWARD S. SKILLIN, formerly second vice-president, has been made senior vice-president, and GEORGE P. SEELEY, JR., the present Havana manager of the company, and RANDALL CREMER, general manager of the company at New York, were elected vice-presidents. FREDERICK SNARE, JR., has been re-elected secretary and treasurer, and F. J. LITTER, chief engineer. All of the officers concerned have had long service with the company, some of them since its organization in 1900, when it was known as Snare & Triest, Inc. ALAN B. MILLS, formerly director of architecture and construction, State of New Jersey, and more recently director of construction for the J. C. Penney-Gwinn Corp. in Florida, has become associated with the corporation.

WALLACE R. HARRIS, Chicago, Ill., has joined the organization of the Concrete Products Corporation as its engineer. Mr. Harris has long been an authority on concrete. From several years' work on large concrete contracts in Canada, Mr. Harris passed to the position of engineer in charge of the Cement Products Bureau of the Portland Cement Association. Then he joined the staff of the International Trade Press, in Chicago, and helped to organize the Concrete Products Association (National) of which he was president for five years; he was also managing editor of two papers, *Concrete Products* and *Highway Engineer and Contractor*. He is author of the reference book, "Concrete Products, Their Manufacture and Use." Mr. Harris is president of the American Association of Engineers.

A. C. LITTLE, formerly engineer in power plant work for the Illinois Northern Utilities Co., has become construction foreman for the U. G. I. Contracting Co. in the work of setting tower foundations for transmission lines; he is located at Waterbury, Conn.

A. S. KARSHER has changed from work as resident engineer for the Missouri State Highway Department to the same work for the Kentucky State Highway Department, and he is at present at West Liberty, Lexington, Ky.

REGINALD W. MURRAY, formerly president of the Fred F. French Management Co., New York City, and FRANK BAGGE, formerly general superintendent of the Fred F. French Co., have formed a company to be known as the Bagge-Murray Co., Inc., Builders, with offices at 12 East 41st St., New York City; the company will specialize in building construction. Mr. Murray is president.

L. L. FLINT is now engineer on road and bridge construction for the Iowa State Highway Commission at Sanborn, Iowa; formerly he was a bridge designer for the Tennessee State Highway Department.

ELSON T. KILLAM, formerly assistant superintendent of the water board at New Bedford, Mass., has joined the staff of Frank A. Barbour, consulting engineer, Boston, Mass., as an assistant engineer.

Obituary

NOLEN O'DANIEL, chief engineer, City Planning Commission, Denver, Colo., died August 14. Mr. O'Daniel had been in failing health for some time. He was a native of Coffey, Mo., going to Denver to practice about 17 years ago.

WILLIAM B. DAVIS, who had been employed by the Canadian government since 1910 as division superintending engineer for the Trent Valley canal and was located at Washago, Ont., died July 26 in a hospital in Toronto after a lingering illness. Mr. Davis was a graduate of the University of Toronto.

MURRAY ROE, formerly a consulting engineer in New York, was found dead in Central Park recently; he had been in ill health for some time.

G. DANA EMERSON, former subway engineer at Boston, who retired from active business life some time ago, died suddenly on the tennis court at his summer home at Estes Park, Colo., on Aug. 23. Mr. Emerson was 50 years of age.

HENRY SEWALL ADAMS, consulting engineer, Boston, Mass., died suddenly Aug. 21 of heart disease at his home in Arlington, Mass., aged 63 years. Mr. Adams graduated from the Massachusetts Institute of Technology in the class of 1887. As a consulting engineer he dealt chiefly with sugar refineries in Boston, New Bedford, Portland and St. Johns.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Meeting, Boston, Mass., Sept. 13-16, 1927.

AMERICAN WELDING SOCIETY, New York City; Fall Meeting, Denver, Colo., Oct. 3-6, 1927.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual meeting, Dentroit, Mich., Sept. 19-23, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Fall Meeting, Columbus, Ohio, Oct. 12-14, 1927.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; Fall meeting, Birmingham, Ala., Oct. 17-19, 1927.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Dallas, Texas, Nov. 14-18, 1927.

ASPHALT PAVING CONFERENCE: Under the auspices of the Asphalt Association and Association of Asphalt Paving Technologists; annual conference Atlanta, Ga., Nov. 28-Dec. 2, 1927.

HIGHWAY RESEARCH BOARD, NATIONAL RESEARCH COUNCIL, Washington, D. C.; Annual meeting, Washington, D. C., Dec. 1 and 2, 1927.

THE PUEBLO ENGINEERS SOCIETY, Pueblo, Colo., at its August 24 meeting was addressed by G. N. Robinson, engineer of the General Electric Co., Denver.

THE AMERICAN SOCIETY FOR STEEL TREATING and the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers will hold a joint meeting (their first) in Detroit, Mich., Sept. 19 to 24 at the Book-Cadillac Hotel. The American Welding Society will hold its meeting in Detroit Sept. 19 to 23 as shown by the adjoining engineering societies calendar, and in the same hotel.

THE SAN FRANCISCO SECTION, American Society of Civil Engineers, at the regular bi-monthly meeting on Aug. 16 held a general discussion on "The Design of Modern Office Buildings." Different angles of the subject were presented by H. J. Brunnier, consulting structural engineer, George W. Kelham, architect, and R. A. Hudson, consulting engineer. A short talk on the use of terra cotta in building construction was presented by E. T. Fisher, junior member. The latter is in line with the Section's policy of having five-minute talks on subjects of current engineering interest by younger members of the profession.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Welding Conference to be Held at University of Minnesota

A conference embracing all phases of the welding industry is to be held at the University of Minnesota, October 20, 21 and 22, 1927, according to plans worked out by Prof. S. C. Shipley, acting head of the mechanical engineering department of the college of engineering. This is the first conference of this nature held by the University of Minnesota, and it is felt that the interest shown by the users of welding equipment in that territory warrants making such a conference a yearly event. A large part of the program is to be devoted to papers read by practical users as well as to round table discussions led by experts in their respective lines.

Brown Hoist and Industrial Works Combine

Directors of the Brown Hoisting Machinery Co., Cleveland, and Industrial Works, Bay City, Mich., have approved plans for a merger of the two companies, to be made effective when ratified by their respective stockholders. The new company name will be Industrial Brownhoist Corp. The businesses to be joined both occupy outstanding positions in the materials handling industry and the merger is the culmination of work on the part of the late E. B. Perry, formerly president of the Industrial Works, and A. C. Brown, president, Brown Hoisting Machinery Co.

The object of the consolidation is said to be the elimination of duplication or overlapping of product where it exists and the rendering of better service to users of material handling equipment.

Brown Hoisting Machinery Co. was founded in 1880 by Alexander E. Brown. It designs and manufactures hoisting and conveying appliances and heavy handling machinery, including locomotive cranes, grab buckets, combination shovels and cranes, ore unloaders, bridge cranes, gantry and portal cranes, trolleys, hand traveling cranes, and conveyor equipment. The principal plant of the company is in Cleveland while at Elyria, Ohio, twenty miles from Cleveland, is situated its iron and bronze foundry.

Industrial Works was founded in 1873 by George C. Kimball, James Clements, E. Wells and Charles R. Wells. E. B. Perry became president in 1924 and held the position until his death August 7 last. This company designs and builds locomotive cranes, wrecking cranes, heavy duty and full revolving pile drivers, crawler cranes and shovels for gasoline, steam, electric or Diesel operation, gantries, pillar cranes, rail saws, buckets, and steam hammers. It also manufactures large coke oven machinery. The plant is complete, having its own steel, iron and brass foundries, and all other departments necessary to build its product from the ground up.

It is stated that the consolidation will join under one management assets of approximately $13,000,000. The combined sales of both companies totaled over $7,700,000 in 1926. Both plants will be continued in operation, and no radical changes of any sort are contemplated.

Business Notes

Dorr Co., New York City, announces that it has established a service department in charge of H. A. Linch. The purpose is to give customers specialized assistance in connection with the installation and initial operation of the company's equipment. Mr. Linch has been associated with the Dorr Co. for eight years, and has had a wide and varied experience in chemical, metallurgical and industrial operations.

Charles A. Perryman, former sales manager, wire rope department, Wickwire-Spencer Steel Co., Inc., is now associated with the American Cable Co., New York City, as assistant sales manager.

R. H. McGredy has been appointed sales manager of the Lo-Hed Hoist division of the American Engineering Co., Philadelphia.

Thew Shovel Co., Lorain, Ohio, announces that M. B. Garber has joined its sales organization. Mr. Garber was for ten years with the Sanderson-Cyclone Drill Co., Orrville, Ohio, during the last five of which he served as sales manager.

Harnischfeger Sales Corp., Milwaukee, Wis., announces the opening of a new branch office at 524 Buder Building, St. Louis, Mo., in charge of L. J. DeHoney.

Atlas Conveyor Co. has recently opened offices at 20 S. Fifteenth St., Philadelphia. Associated with this company will be P. K. Reed, L. G. Weygandt and E. A. Thumlert, all of whom were formerly connected with the R. H. Beaumont Co. as chief engineer, eastern sales manager and general manager, respectively. This company will design and build elevators, conveyors, skip hoists, cable drag scrapers, ash hoppers, and similar equipment.

Garrison Fire Detecting System, Inc., New York City, announces that its Baltimore office is now in operation under Walter R. Hough, vice-president, who has a complete engineering staff for making fire surveys. The office is equipped with a demonstration room where Garrison systems are shown under actual fire conditions.

New Developments

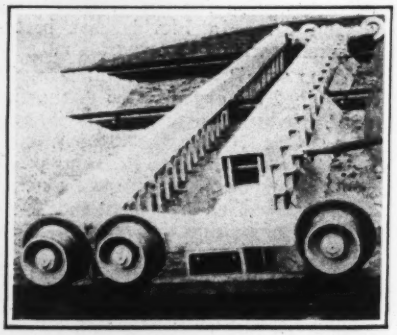
New ½-Yard Power Shovel

There has recently been added to the line of machines manufactured by the Harnischfeger Corp., Milwaukee, Wis., a new ½-yd. excavator which has been under test during the past two years. It is known as the "Groundhog" and equipped with a 50-hp. motor, a standard 18-ft. boom, 13 ft. 3-in. dipper sticks and a heavy plate steel dipper it weighs 40,500 lb. Fast line speeds are claimed and it has a revolving rate of 5½ times

per minute. The machine is convertible for use as a shovel, dragline, or clamshell, handling in the latter case a ½-cu.yd. bucket on a 35-ft. boom, and having a lifting capacity of 11,400 lb. at 12-ft. radius.

Combination Scratch Templet and Clean-up Scraper

A new combination machine, consisting of a subgrade tester, commonly called a scratch templet, and a clean-up blade or trail grader, is a new product of Ted Carr & Company, Chicago. The scratch templet is on a separate wheel so that the vertical movements of

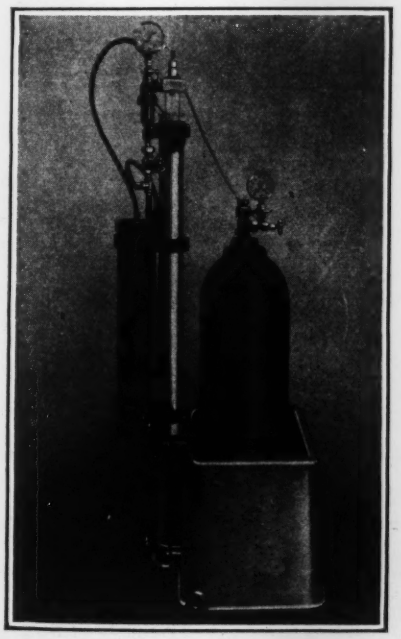


the clean-up blade will not lift it from the forms. However, either the scratch templet or the clean-up blade may be furnished separately.

The trail grader is primarily made to be pulled by a paving mixer. It does the final cleaning up of the subgrade, or else carries a pile of sand in front of it to fill up low places. It may also be used to spread concrete where a smooth top is not desired, such as on a subbase for asphalt pavement. It can be furnished, if desired, with crank axle and wheels at its center to assist in moving it. The blades are sharp on both edges and are adapted to be used either with or without a center joint or side rod reinforcing. The end trucks hold the beam at any desired height, and the blade across the road to any desired profile below the top of the forms. The cross beam is made of a rectangular box section giving great stiffness and especially designed so that there are no open channels that can fill with concrete. The beam is adjustable to widths of road from 14 to 24 ft.

Design of New Chlorinator Eliminates Many Parts

The design of a new thermo-type solution feed chlorinator known as type TS, manufactured by the Paradon Mfg. Co., Arlington, N. J., has permitted its construction with less than one-third of the former number of parts. The most important factor contributing to this simplicity is the placing of the 100-lb.



chlorine cylinder in a water bath. This water bath keeps the cylinder at approximately constant temperature which means also a constant pressure, and thus the usual chlorine pressure-reducing and constant-pressure devices are eliminated.

The chlorine passes from the cylinder through a control valve and then into a glass-bubbling type volumetric meter. From this the chlorine and water solution is drawn into an injector which applies the chlorine to the water or sewage. Part of the auxiliary water supply operating the injector is used to keep a small amount of water circulating in the water bath. The bubbling meter is enclosed in a glass cylinder which fills with water as soon as the injector is in operation, the water acting as a medium to make visible the bubbles of gas released from the meter. When the injector ceases to operate, the vacuum inside the glass cylinder is released and the water level drops to the level of the overflow of the water bath. This new chlorinator is applicable for treating small water supplies, small sewage plants and practically all swimming pools.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL HARDWOOD LUMBER ASSOCIATION, Chicago; Annual Convention, Chicago, Sept. 15-16.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; Semi-annual meeting, Aviation Country Club, Detroit, Sept. 19-21.

AMERICAN PAINT & VARNISH MANUFACTURERS ASSOCIATION, Philadelphia; Annual Convention, Atlantic City, Oct. 24-25.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, New York; Annual convention, Pinehurst, N. C., Oct. 25-29.

NATIONAL ASSOCIATION OF MANUFACTURERS; Annual meeting, Chattanooga, Tenn., October 25, 26 and 27.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; Annual Convention, Cleveland, Ohio, Jan. 9-14, 1928.

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; Annual Convention, West Baden, Ind., Jan. 16-19, 1928.

New Publications

Portable Conveyors—PORTABLE MACHINERY Co., Clifton, N. J., has made available a 30-page catalog illustrating and describing its many types of portable conveyors. These include the company's special scoop conveyor, the flight conveyor, and other special adaptations of belts to conveyor practice.

Reinforcing Lath—MILWAUKEE CORRUGATING Co., Milwaukee, Wis., has issued a new catalog No. 20-D devoted exclusively to its Milcor ¾ inch Stay-Rib reinforcing lath. This catalog is a supplement to the 1927 edition of the Milcor Manual and has been prepared especially as a technical data book for architects, engineers and contractors. The material is illustrated and described and its principal uses pointed out. Most of the engineering data are based on results of construction tests which have recently been made on the metal lath.

Drag Scrapers—R. H. BEAUMONT Co., Philadelphia, has recently issued catalog No. 95 devoted to its cable drag scraper for handling sand, gravel, stone and other bulk materials. All the units that make up the system are described and illustrated in detail, including hoists of electric, gasoline and belt drive types, scraper buckets, cables, tramcars and material bin gates.

Well Points—MOORE TRENCH MACHINE Co., Rockaway, N. J., has just published a 22-page catalog describing its well points and well point system. Many illustrations are given showing the use of the well points on difficult work and a number of published letters from contractors testify to its satisfactory use.

Contractors' Equipment—A. S. ALOE Co., St. Louis, Mo., has issued Bulletin 101, describing its many types of contractors' equipment. Such products as table saws, electric hand saws, hand derricks, cement finishing tools, small pumps and mixers, surveying instruments, drawing sets, floor finishers, blow torches, tool sets, etc., are featured.

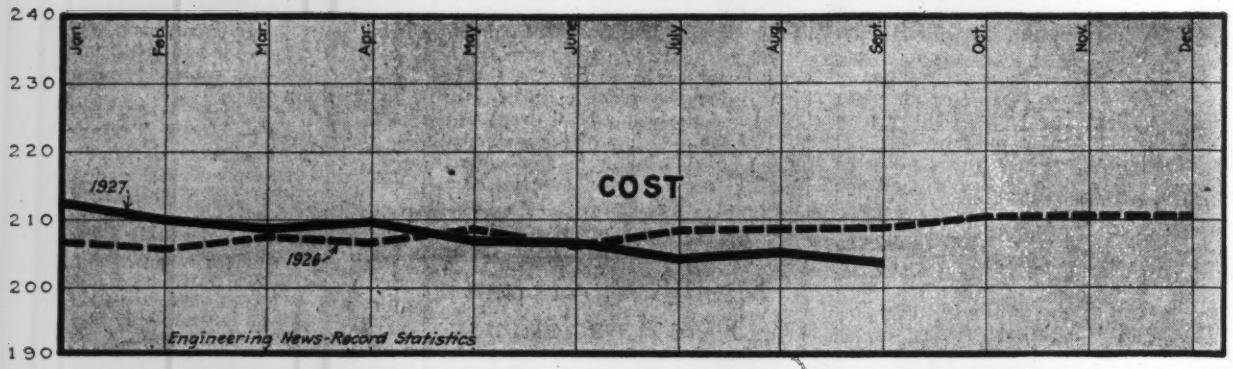
Lighting Data—EDISON LAMP WORKS, Harrison, N. J., recently made available two bulletins, No. LD 147A and No. LD 155, devoted respectively to lighting for street traffic control and to illumination terms. The first bulletin contains information compiled by E. F. Prideaux of the company's engineering department and considers such subjects as necessity, effectiveness, and costs of traffic control, discusses manual and automatic control systems, and describes types of signals and optical systems, in addition to giving a page of bibliography. The pamphlet on illumination terms contains 56 pages arranged in encyclopedia fashion, giving the various terms and their definitions and where possible including sketches.

Recording Ammeters—BRISTOL Co., Waterbury, Conn., has devoted its most recent catalog No. 1502 to a description of its recording ammeters. Various models are illustrated and described and complete information is given on the use of such equipment where it is desired to have a running story of electric current consumption.

Floor Hardener—ADENSITE Co., INC., New York City, has recently issued a pamphlet describing its Adaflint an applied hardener in crystal form.

Belt Conveyors—FAIRFIELD ENGINEERING Co., Marion, Ohio, has issued its Bulletin No. 65 describing its new portable belt conveyors. Information and illustrations are given on the various mechanical details of the conveyors and a table of condensed specifications gives a comprehensive description of the machines.

Engineering News-Record Statistics of the Construction Industry



Engineering News-Record CONSTRUCTION COST Index Number (1913 = 100)

MONTHLY

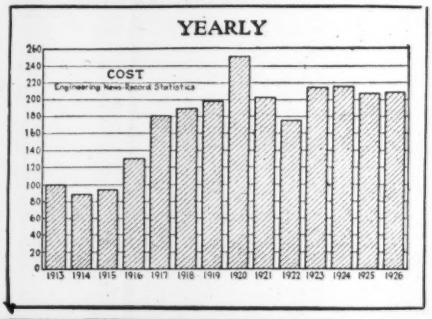
September, 1927	203.60
August, 1927	205.50
September, 1926	208.30
Peak, June, 1920	273.80
1913	100.00

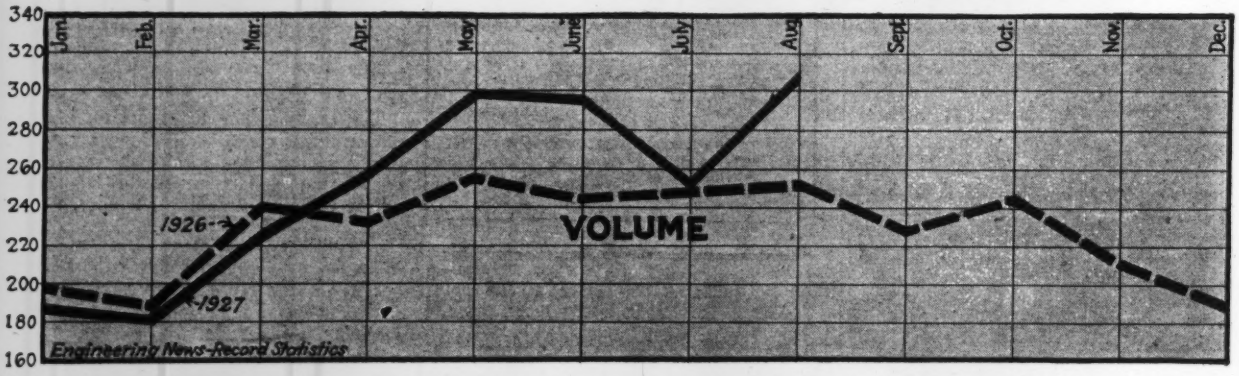
1927

Jan. 211.50	Mar. 208.80	May 206.80
Feb. 210.15	April 209.00	June 205.55
July 203.68	Aug. 203.60	

Engineering News-Record's Construction Cost Index Number is 1 per cent below August 1, 1927. The decrease is due to slightly lower wage rates. The average rate for common laborers is 54.55 cents per hour. Thus, general construction cost is 2 per cent below August, 1926, and 26 per cent under the peak and 104 per cent above 1913.

YEARLY





Engineering News-Record CONSTRUCTION VOLUME *Index Number (1913 = 100)*

MONTHLY

January, 1926, to July, 1927

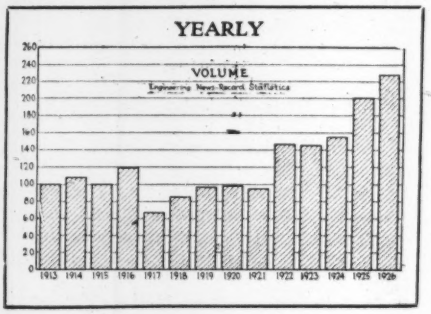
August, 1927 (record)	306
July, 1927	252
August, 1926	252
May, 1927	299
1913	100

1927

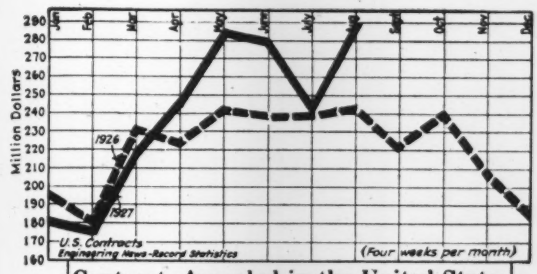
Jan. 187	Mar. 226	May 299
Feb. 182	April 257	June 297
July 252	Aug. 306	

Engineering News-Record's Construction Volume Index Number is 306 for the month of August and 288 for the whole of 1926, as against 100 for 1913. This means that the actual volume of contract letting in 1926 (not the mere money-value of the contracts let that year) is 128 per cent above the volume for 1913. The monthly volume number, 306 for August, 1927, indicates the rate at which contracts are being let as compared with 1913 awards.

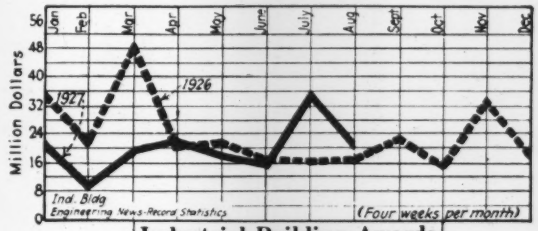
YEARLY



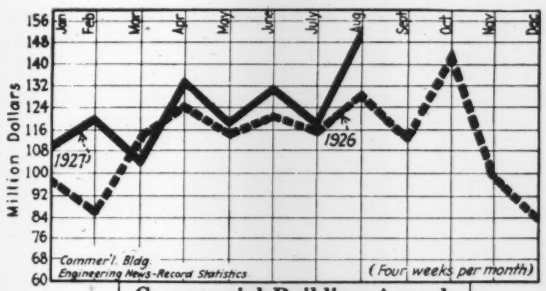
Monthly Statistics of the Construction Industry



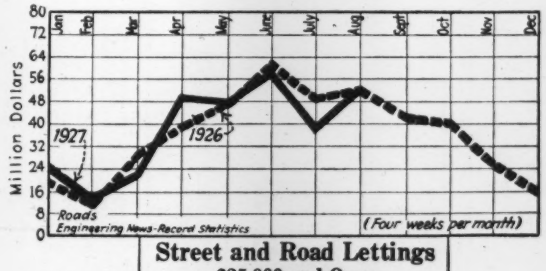
Contracts Awarded in the United States
Reported by E. N.-R.



Industrial Building Awards
$40,000 and Over

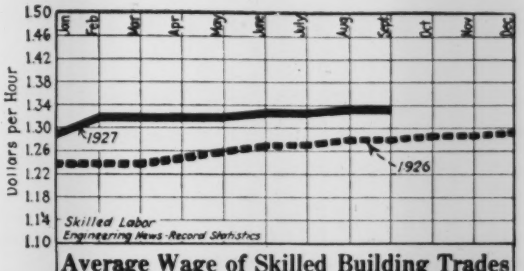


Commercial Building Awards
$150,000 and Over

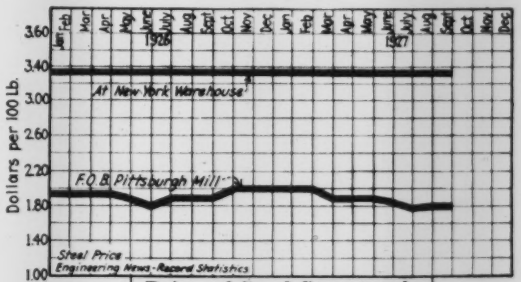


Street and Road Lettings
$25,000 and Over

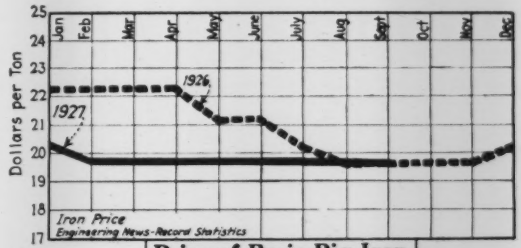
Average Common Labor Rate
Pick and Shovel Men



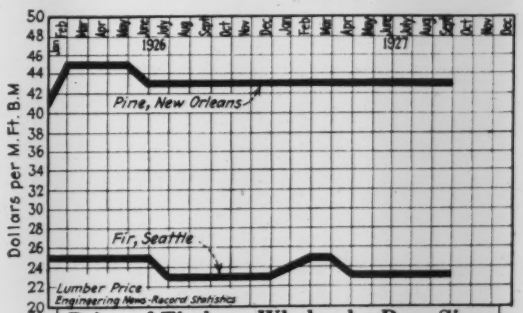
Average Wage of Skilled Building Trades
Bricklayers, Carpenters and Steel Erectors



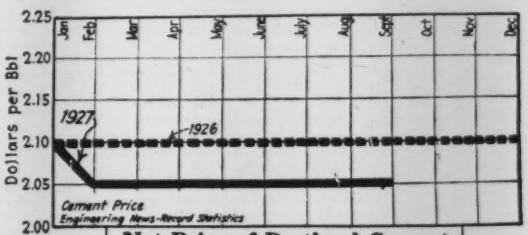
Price of Steel Structurals
Shapes 3-in; Plates ¼-in.



Price of Basic Pig Iron
F.o.b. Pittsburgh



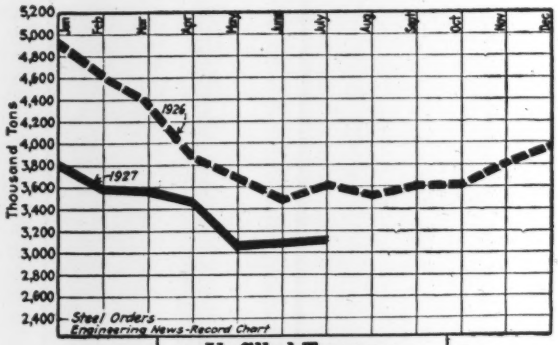
Price of Timbers, Wholesale, Base Sizes
Car Lots to Contractors



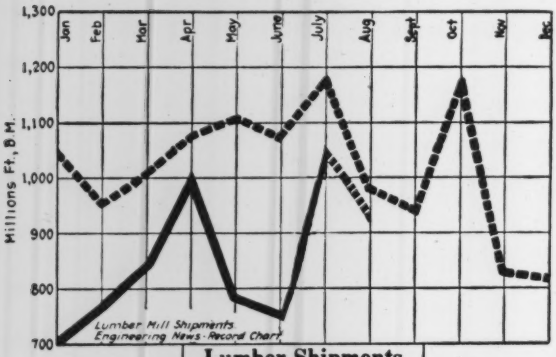
Net Price of Portland Cement
Car Lots F.o.b. Chicago

Monthly Statistics of the Construction Industry

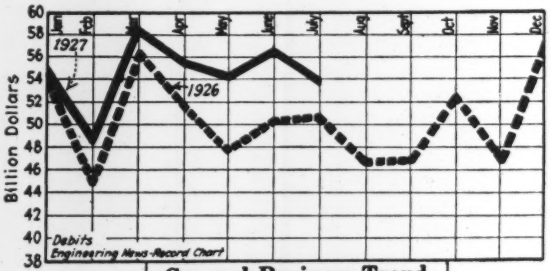
Price of Brick
At Dock, New York



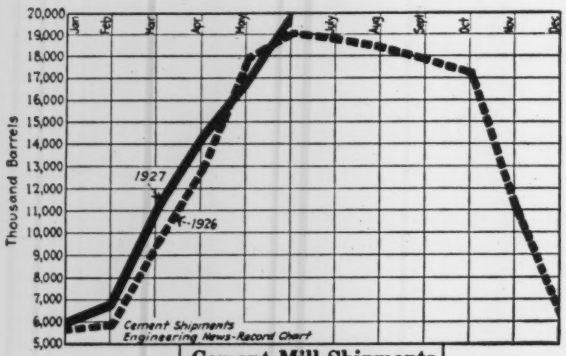
Unfilled Tonnage
On Books of U. S. Steel Corp.



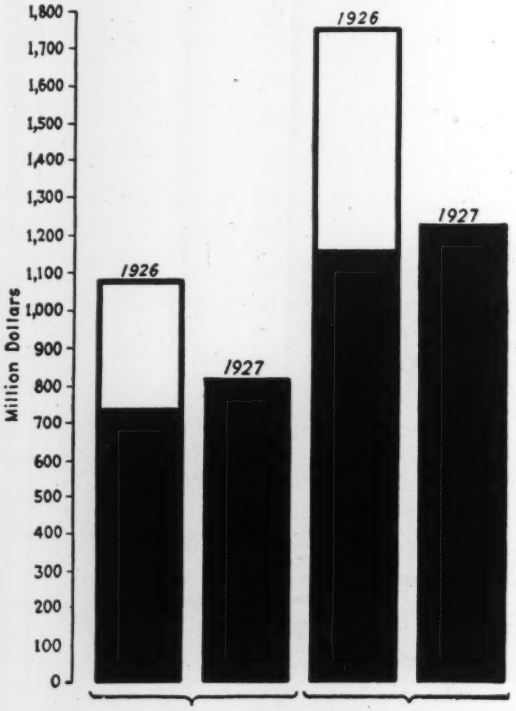
Lumber Shipments
Nat. Lumber Mfrs. Assn.



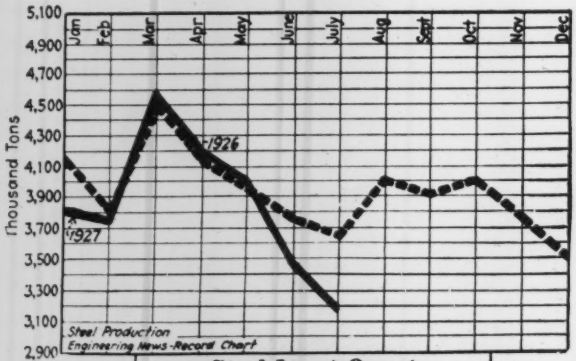
General Business Trend
Bank Debits—Federal Reserve



Cement Mill Shipments
Bureau of Mines



Public—Contracts—Private
Jan. 1 to date ——
Reported by E. N.-R.



Steel Ingot Ouput
Gross Tons; Am. Iron and Steel Inst.

August Awards 20 Per Cent Ahead of July—1927 Still Leads

CONTRACTS awarded for the United States for August 1927, were $289,344,000, which is 20 per cent more than awards for July and 19 per cent more than August, 1926. The total since Jan. 1 of $2,044,973,000 is 7½ per cent higher than the same period last year.

All classes of construction except industrial works and federal government contracts show an increase over last month. New England shows a slight decrease from last month's total for all classes. The Middle West shows the most spectacular increase, the total for that section being about 70 per cent higher than last month. Commercial contracts in the states of Illinois and Michigan are about five times as large as last month. These states compared with last year, however, register a less conspicuous change. The Illinois figure is slightly lower than August, 1926, and Michigan is about twice as high. From Jan. 1 this year the Middle West has increased only about 6 per cent over last year.

The total contracts for the Southern states since the first of the year are lower than last year but all other sections are higher. The only classes of construction which have lower totals for this year to date are streets and roads, industrial works, and federal government. Excavations are 75 per cent higher than last year. The following changes over 1926 are of significant magnitudes: Increases—bridges, 50 per cent; unclassified, 42 per cent; sewers, 19 per cent. Decreases—industrial works, 19 per cent; federal government, 16 per cent. In various sections of the country important changes are: Far West, 30 per cent increase; west of Mississippi, 25 per cent increase; Southern, 25 per cent decrease.

Contract values in the accompanying table are based on a minimum for each class, as follows: water-works, excavation, drainage, irrigation, levee, river and harbor projects, $15,000; other public works, $25,000; industrial buildings, $40,000; commercial, educational, institutional, religious and other buildings, $150,000. These figures are for the entire United States.

Foreign Construction Projects

A recent decree of the President of Venezuela provides for an additional credit of $380,000 for the Department of Public Works. All the money that the department now has at its command, over $7,000,000, will be spent for the construction of public works and purchase of materials.

The Government of Chili has provided $4,800 for preliminary studies to be made by engineers of the Office of the Inspector General of Ports, Santiago, in connection with the construction of adequate ports for Valdiva, to cost £1,000,000. Bids for the construction work will be called this month.

The Argentine Government will construct the Costanro Canal with government owned machinery. The necessayr dredging has already been carried out in part, the average depth being 10 ft. Any additional equipment will be purchased after the annual publication of tenders in the Bolletin Official.

Exemption from taxation has recently been granted by law to any official or corporation constructing a hotel in Bahai, Brazil. The plans of the hotel must be approved by the governor of the state of Bahai and municipal authorities, the construction to begin within 60 days after approval. It must be a first-class hotel.

The commission appointed by the Podesti of Milan, Italy, in January to study the possibility of constructing a subway recently submitted its reports recommending the construction of two comparatively short tunnels to contain four principal surface lines. The construction is planned to start this year and to be completed in two years.

VALUE OF CONTRACTS IN THE UNITED STATES AND CANADA
Thousands of dollars (-000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Jan. 1 to Date, U. S.	Canada
Waterworks	$655	$1,394	$856	$882	$2,440	$1,673	$7,900	**$41,213**	.....
Sewers	603	620	648	7,730	1,393	2,925	13,919	**77,181**	$1,063
Bridges	167	2,266	1,006	1,471	1,958	785	7,653	**79,691**	2,246
Excavations, drainage, etc.	25	264	18	598	1,081	769	2,754	**34,320**	194
Streets and roads	1,395	10,425	8,379	11,507	12,993	7,277	51,976	**334,185**	1,785
Industrial buildings	3,277	3,983	1,481	2,446	6,244	3,183	20,614	**172,966**	1,050
Commercial buildings	13,720	55,863	5,852	48,112	12,626	16,844	153,017	**1,048,322**	5,825
Federal government	371	93	1,471	379	1,058	451	3,823	**32,128**	.....
Unclassified	217	8,117	6,132	648	11,302	1,272	27,688	**224,967**	1,064
Aug., 1927	20,430	83,025	25,843	73,773	51,095	35,178	289,344	**2,044,973**	13,227
July, 1927	22,007	78,092	21,990	43,806	42,047	32,708	240,650	.....	5,849
Aug., 1926	17,977	76,648	19,767	65,070	38,393	25,161	243,016	.....	7,444
Jan. 1 to date, 1927	**162,509**	**624,235**	**151,304**	**496,608**	**361,879**	**248,438**	**2,044,973**	.....	**76,415**
Jan. 1 to date, 1926	155,170	592,967	202,271	469,832	289,102	192,708	1,902,122	.....	86,842

Labor Rates and Conditions Throughout the Country

Baltimore, Md.—Bricklayers, carpenters, hod carriers and common laborers are plentiful and the supply of hoisting engineers, pile drivers and structural iron workers is normal. Wage rates have not changed for any of the building trades.

Birmingham, Ala.—An over supply of common labor is reported and a good supply of bricklayers and carpenters.

Boston, Mass.—Carpenters and common laborers are very plentiful and there is no shortage in other classes of labor.

Chicago, Ill.—There is a plentiful plentiful supply of all building mechanics.

Dallas, Tex.—All classes of labor seem well employed except a small surplus of pile drivers and common labor.

Detroit, Mich.—There is a surplus of available men in all trades but no change in labor rates in the construction field.

Los Angeles, Calif.—The rate for pile drivers is now $0.87½ as compared with the previous rate of $1.00 per hour. A good supply of all construction labor prevails and there is no labor trouble.

Montreal, Que.—There is a scarcity of bricklayers and structural iron workers but an ample supply of all other labor.

Pittsburgh, Pa.—Hoisting engineers are receiving $1.50 per hour compared with a previous range of $1.37½@$1.50. Non-union common labor rates are $0.40@$0.50. The supply of all classes is sufficient for present demands.

San Francisco, Calif.—Conditions in the building trades are very dull at present.

Seattle, Wash.—Because of building permits issued exceeding last years figures builders anticipate considerable fall activity. Logging camps are working 65% of capacity and lumber mills 80%. Great Northern Tunnel project is using 21,000 men and this mill will continue throughout the winter.

Labor Disputes and Settlements

New York, N. Y.—Jurisdictional question of the cement workers has been settled by the agreement between the operative plasterers and cement finishers union and the bricklayers, masons and plasterers' union. The pact signed was developed in a confer-

Current Building Trades Wage Rates Per Hour

(Higher rates than a month ago indicated by +, decreases by—)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.40	$0.70	$0.70	$0.50	.....	$0.75	$0.25@.30
Baltimore	1.62½@1.75	1.00@1.10	1.00@1.37½	1.00	$0.65	1.00@1.25	.40
Birmingham	1.00@1.50	1.05	1.00	.50@.75	.....	1.75	.25@.40
Boston	1.40	1.25	1.25	.79	1.15	1.25	.45@.74
Cincinnati	1.50	1.35	1.35	.97½	1.35	1.35	.45@.60
Chicago	1.62½	1.10@1.50	1.00@1.50	.90@.96¼	1.50	1.50	.82½@.90
Cleveland	1.62½	1.37½	1.30	.87½	1.10	1.50	.87½
Dallas	1.62½	1.12½	1.00	.40@.75	1.00	1.25	.30@.50
Denver	1.50@1.62½	1.25	1.25@1.37½	.87½@1.00	....	1.25	.31¼@.50
Detroit	1.56¼	1.00@1.25	1.00@1.10	.90	1.00@1.10	1.00@1.25	.50@.60
Kansas City, Mo	1.50	1.25	1.25	.90	1.25	1.25	.35@.75
Los Angeles	1.37½	1.00	1.00	.87½	—.87½	1.00	.50
Minneapolis	1.25	.87½@95	.87½	.75	....	1.00	.45@.60
Montreal	1.25	.75	.75	.40	.50	.85@.90	.30@.35
New Orleans	1.50	.90	1.25	.75	.80@1.00	1.25	.30@.40
New York	1.75	1.50	1.75	1.12½	1.00@1.12½	1.75	.90⅝
Philadelphia	1.62½	1.12½@1.25	1.02¼	.70@1.12½	1.00	1.37½@1.50	.45@.50
Pittsburgh	1.70	1.50	+1.50	1.12½	....	1.50	—.40@.80
St. Louis	1.75	1.50	1.50@1.65	1.15@1.25	1.25	1.50	.40@.75
San Francisco	1.37½	1.12½	1.00@1.12½	.87½	1.12½	1.37½	.50@.60
Seattle	1.37½	1.12½	1.00@1.12½	1.00	1.00@1.12½	1.12½@1.25	.62½@.70

ence arranged by William Green, president of the Amreican Federation of Labor. It is expected this dispute which has lasted several years is completely ended by this agreement. Recent trouble was occasioned by opposing constructions placed on the terms laid down by Mr. Elihu Root who acted as arbiter for the settlement of the original dispute.

St. Louis, Mo.—Sympathetic strikes on the St. Louis High School Athletic Field and Stadium and a commercial building in East St. Louis, Ill., for which Murch Bros. Construction Co. of St. Louis, Mo., are the general contractors have followed the labor trouble on a new Veterans Hospital being being erected by the same contractors at Quincy, Mass.

The Quincy building laborers were employed on an open shop basis although the building mechanics were union men. A drive is on to unionize the laborers in Boston and vicinity, and the laborers on the hospital quit work, followed by the St. Louis and East St. laborers. Skilled crafts have taken no part in the controversy but they cannot work without the laborers.

Toronto, Ont.—Union plumbers went on strike demanding an increase of 15c. an hour over present wages of $1.00 an hour. The Master Plumbers' Association declined to grant this increase saying that the cost of living does not warrant it.

Wages and Hours in the Iron and Steel Industry in 1926

For the iron and steel industry as a whole the average earnings per hour were 63.7 cents in 1926, according to a report of the U. S. Department of Labor covering 75,000 employees in the ten departments. The peak was in 1920, 74.5 cents and in 1922 a low rate of 51.3 cents was reached. In 1924 the average rate was 64.4 cents. Earnings in 1926 are 2⅛ times those of 1913.

The average full time earnings per week for the entire industry were:

		Per Cen Change
1913	$18.89	.....
1920	45.65	+142.
1922	35.67	— 26.4
1924	35.22	+ 4.5
1926	34.41	— 2.3

Working time of employees shows great improvement over 1913. The greatest decrease has taken place since the 8-hr. day was adopted in a large number of plants in the latter part of 1923. The number of hours for an average full time week changed as follows:

1913	66.1
1914	64.9
1915	65.5
1920	63.1
1924	55.2
1926	54.4

Babbitt metal consumed by producers in July, 1927, was 1,442,461 lb., compared with 1,338,800 lb. in July, 1926.

Fabricated steel plate bookings in July were 43.9 per cent of capacity, compared with 35.9 in June and 45.1 in July, 1926.

Domestic pumps and water systems shipped in July, 1927, numbered 7,586 water systems 35,367 pumps, and 11,464 cylinders, compared with 7,830, and 52,616, and 21,325, respectively, in July, 1926.

Tonnage of ships of 100 gross tons or more, under construction on Aug. 1, totals 200,105 for steel and 18,649 for wood. These were 196 steel vessels and 43 wood. Companies reporting numbered 196.

Oil output declined for the third successive week in the week ended Aug. 27. The daily average was 2,506,900 bbl. against 2,518,500 bbl. the week before. The peak was 2,577,150, reached three weeks before.

In commenting upon the article, "Unit Costs on Power Plant at Fairfax, Oklahoma," p. 246, Aug. 11 issue, V. L. Taylor, asssitant engineer of the Nebraska State Railway Commission, writes: "We are very much interested in things of this kind and appreciate these good articles in your magazine." *Engineering News-Record* urges its readers to contribute to its construction costs pool.

Bridge metal costs, as represented by the low bids submitted on June 20 for the $470,000 bridge between South Norfolk and Portsmouth, are as follows:

	Per Lb.
Span and tower metal	$0.0647
Trestle metal	.0440
Handrails	.0475
Sheaves, shafts, bearings	.1870
Operating machinery	.2230
Wire ropes	.1955
Balance chains	.0500

Prices bid on certain items in the New York State highway lettings on Aug. 12, ranged as follows:

County	Cement Bbl.	Reinforcing Bars, Lb.	Concrete Structure 1x2x3½ Cu.Yd.	Bit. Mat. Waterproof, Sq.Ft.
Broome	$2.50@$2.80	$0.05@$0.055	$15@$24	$0.05@$0.10
Erie	2.30@ 2.70	.04@ .07	15@ 20	.10
St. Lawrence	2.90@ 3.20	.05@ .06	16@ 21.30	.10@ .12
Cattaraugus	2.70@ 3.00	.05@ .06	15@ 25	.10
Nassau	2.56@ 3.10	.045@ .07	.....	.10@ .12
Lewis	2.80@ 3.00	.05@ .06	16@ 20	.10@ .12
Rensselaer	2.50@ 2.75	.05@ .06	14@ 20	.11

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton f.o.b.:

	Sept. 1	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25@2.75)	*$21.44*	$24.19
Northern Basic	20.89	20.39
No. 2 Southern Ohio (silicon 1.75@2.25)	21.19	21.39
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25@2.75)	*25.62*	27.37
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@2.75)	*17.75*	21.00
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	*21.76*	22.76
Virginia No. 2 (silicon 2.25@2.75)	27.17	28.67
Basic	*21.26*	21.26
CHICAGO		
No. 2 Foundry Local (silicon 1.75@2.25)	21.00	21.75
No. 2 Foundry Southern (silicon 2.25@2.75)	*22.80*	25.05
PITTSBURGH, including freight charge ($1.76) from the Valley		
No. 2 Foundry Valley (silicon 1.75@2.25)	20.26	19.76
Basic	19.76	19.76
Bessemer	21.26	19.76

SCRAP—The prices following are f.o.b. per ton paid by dealers:

	New York	Chicago	Birmingham
No. 1 railroad wrought	$11.75@$12.25	$11.50@$12.00	$11.00@$12.00
Stove plate	8.75@ 10.00	13.00@ 13.50	13.00@ 14.00
No. 1 machinery cast	15.25@ 16.25	15.00@ *15.50*	15.00@ 16.00
Machine shop turnings	6.75@ 7.25	*7.00@ 7.50*	8.00@ 8.50
Cast borings	7.25@ 7.75	9.50@ 10.00	8.00@ 8.50
Railroad malleable	11.00@ 11.50	12.75@ 13.25	12.00@ 13.00
Re-rolling rails	10.50@ 11.00	13.75@ 14.25	15.00@ 16.00
Re-laying rails	23.25 @ 24.25		22.00@ 23.00
Heavy melting steel	7.00 @ 11.10	11.75@ 12.25	12.00@ 12.25

Railway Supplies

STEEL RAILS—The following quotations are per ton f.o.b. for carload or arger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh Sept. 1	Pittsburgh One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	.....
Standard openhearth rails	43.00	43.00	43.00	43.00	*$49.50*
Light rails, 8 to 10 lb	.....	.....	34@36	1.80@1.90*	*1.90**
Light rails, 12 to 14 lb	34@36	.....	34@36	1.80@1.90*	*1.80**
Light rails, 25 to 45 lb	36.00	33@34	34@36	1.80@1.90*	*1.78**
Re-rolled rails	30@34	27@31	.....	34@36	17@18

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft
Chicago, white oak, plain	$1.45	$1.83
Chicago, empty cell creosoted	1.85	2.45
Chicago, zinc treated	1.65	2.15
San Francisco, green Douglas fir	.84	1.14
San Francisco, empty cell creosoted, Douglas fir	1.70	2.25
St. Louis, white oak, plain	1.25	1.50
St. Louis, zinc treated	1.65	1.90
St. Louis, red oak, plain	1.15	1.40
St. Louis, sap pine-cypress	1.00	1.25
Birmingham, white oak	1.25	1.45

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh mill for carload lots, together with the warehouse prices at the places named:

	Pittsburgh Sept. 1	Pittsburgh One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	$2.80@2.90	$2.80@2.90	$3.55	$3.65	$3.85	$3.00
Track bolts	3.90@4.25	3.90@ 4.25	4.55	4.60	5.35	3.90
Standard section angle bars, splice bars or fish plates	2.85	2.75	3.40	3.75	4.25	2.95

Pipe

WROUGHT STEEL AND IRON PIPE—The following percentage discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1¼	30	13
		LAP WELD			
2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			
LAP WELD, EXTRA STRONG, PLAIN ENDS					
2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT-STEEL PIPE—From warehouses at the places named the following discounts hold for welded steel pipe:

	Black New York	Black Chicago	Black St. Louis
1 to 3 in. butt welded	53%	54%	49%
2½ to 6 in. lap welded	48%	51%	46%
	Galvanized New York	Galvanized Chicago	Galvanized St. Louis
1 to 3 in. butt welded	39%	41%	36%
2½ to 6 in. lap welded	35%	38%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 36 −5% off.

CAST-IRON PIPE—The following are prices per net ton for Class B and heavier f. o. b. in car load lots:

	Birmingham	Burlington, N. J.	New York Sept. 1	New York One Year Ago
4 in.	$42.00	*$45.00@46.00*	$48.60	$56.60@57.60
6 in. and over	38.00	*41.00@42.00*	44.60	52.60@53.60
	Pittsburgh	Chicago	St. Louis	San Francisco
4 in.	*$43.20-46.20*	*$43.20*	$44.60	*$47.00*
6 in. and over	*39.20-42.20*	*40.20*	40.60	*43.00*

Gas pipe and Class "A," $ per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

Size, In.	New York Sept. 1	New York One Year Ago	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$45.00	.....	$45.00	.....	$73.00
4	56.00	55.00	*$35.00*	56.00	$76.50	110.00
5	.....	.....	.....	80.00	97.75	118.00
6	80.00	90.00	*65.00*	100.00	127.50	150.00
8	150.00	160.00	*150.00*	165.00	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	....	$0.072	$0.10	....	$.088	$0.12	....
4	....	.072	.10	$0.0875	.088	.15	$0.15
5	....	.099	.135	....	*.11*	.18	.18
6	*$0.22*	.099	.21	.1225	*.11*	.21	.21
8	*.36*	.162	.315	.20	*.18*	.30	.325
10	.52	.2415	.45	.28	*.2625*	.42	.476
12	.66	.3105	.54	.36†	*.3375*	.56	.612
15	1.12†	.414	.75	.60†	*.45*	.92	1.02
18	1.62†	.575	.90	.84†	*.875†*	1.32	1.53
20	1.95†	.69	1.20	....	*1.05†*	....	....
21	....	.805	....	1.12†	*1.225†*	....	....
22	2.60†	.92	1.35	....	*1.40†*	....	1.564
24	2.92†	1.035	2.665	1.44†	*1.575†*	2.16	2.04
27	*4.62†*	2.08	2.952	2.45†	2.75†	3.00	3.34
30	*5.12†*	2.304	3.96	3.00†	3.75†	3.60	4.06
33	*6.93†*	4.05	4.51	3.55†	4.50†	....	4.99
36	*7.91†*	4.6125	5.06	3.95†	5.00†	.....	5.42

	3	5	8	12	24	36
Boston	$0.12	$1.175	$0.25	$0.47	$1.80†	$5.10†
Minneapolis	....	....	.25	.45	1.50	4.56
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	.14	....	.35	.63	2.52	.....
Los Angeles	.1675	.186	.2825	.5085†	2.034†	.....
New Orleans	.114*	.171*	.285	.4845	*1.85*	3.50
Cincinnati	.105	.1575	.245	.4725	1.575	4.715
Atlanta	.10*	.15*	.25	.425	1.625	.....
Montreal‡	....	.50	.90	*1.35*	*4.50*	.....
Detroit	.081	.122	.189	.405	2.07†	4.715†
Baltimore	.111	.166	.259	.499	1.665	4.92
Kansas City, Mo	.135	.15*	.21*	.52	1.90†	3.80†
Philadelphia	.105	.15	.245	.40	1.40	3.50

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡Freight allowed.

Road and Paving Materials

ROAD OILS—Following are prices per gallon in tank cars. 8,000 gal. minimum f.o.b. place named:

		Aug. 4	One Year Ago
New York, 45% asphalt	(at terminal)	$0.0725@$0.075	$0.065 @$0.0
New York, 65% asphalt	(at terminal)	.0675@ .0725	.0625@.072
New York, binder	(at terminal)	.07 @ .075	.07 @.0754
New York, flux	(at terminal)	.07 @ .075	.07 @.0751
New York, liquid asphalt	(at terminal)	.07 @ .075	.07 @.0751
St. Louis, 40@50% asphalt		.042	.055
St. Louis, 50@60% asphalt		.0354	.0565
Birmingham, 55% asphalt		.0475	.0475
Dallas, 45% asphalt		.0495	.0495
Dallas, 50% asphalt		.0455	.0455
Dallas, binder		.061	.061
San Francisco, binder, per ton		12.00*	12.00*

* F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$24.50	.....
Boston (*Mexican*)	23.50	$19.00
Chicago (*Texas*)	23.00	18.50
San Francisco, *f.o.b. refinery*, Oleum, Cal	18.00	12.00
Dallas (*Texas*)	27.10	21.10
Seattle, "*D*" *grade, California, f.o.b. Richmond*	19.50	13.50
Denver (*California*)	24.00	.....
Minneapolis, *f.o.b. Twin Cities* (*Stanolind*)	28.10	22.10
St. Louis (*Mexican*)	26.00	23.00
Baltimore (*Standard Oil*) (*f.o.b. refinery*)	22.50	18.50
Montreal (*Imperial*)	27.00	22.50
Atlanta (*Mexican*)	24.40	19.40
Detroit (*Mexican*)	24.00	19.00
Cincinnati (*Kentucky Rock*)	.....	11.65
Maurer, N. J. (*Bermudez*)	30.00	.....
Maurer, N. J. (*Trinidad*)	23.00	.....
Philadelphia (*Mexican*)	20.00	18.00
Kansas City, Mo. (*Texas*)	27.00	22.00
Los Angeles ("*D*" *grade, California*)	*18.00	*12.00
Birmingham (*Mexican*)	27.00	21.00
New Orleans (*Mexican*)	20.00	17.00

*F.o.b. El Segundo Refinery. Drums used in New York.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade I)	5-in. granite, 30 blocks per sq.yd.	$150.00 per M.
San Francisco	Basalt block 4x7x8	70.00 per M.
Chicago	about 5x8x5 dressed	3.60 per sq.yd.
	about 5x8x5 common	3.25 per sq.yd.
Boston	5-in. Granite	135.00 per M.
Atlanta	Granite	2.50 per sq.yd.
Detroit	5-in. Granite	3.00 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4x8x4	2.75 per sq.yd.
Cincinnati	Granite	135.00 per M.
St. Louis	Granite, 4x8x4	1.65 per sq.yd.
Kansas City	Granite	3.85 per sq.yd.
Philadelphia	Granite	3.90@4.25 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5x16 in., 90c.; *St. Louis*: Class "A" straight, delivered, 5x18 in., 90c. per lin.ft., roundings, $1.55. *Birmingham*: Limestone, 5x18-in., $1.05 per lin.ft.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq. Yd.
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	2.40
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	2.25
St. Louis	4	16	2.50
Seattle	4	16	Off market
Minneapolis	3½	16	2.50
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Cincinnati	3½	16	2.35
Kansas City	4	16	2.50
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Price for cargo or carload lots to contractor, f.o.b., per cu.yd.; weight of sand 1½ tons per cu.yd., gravel, 1½ tons per cu.yd.

	Gravel 1½ In. Sept. 1	Gravel 1½ In. One Year Ago	Gravel ¾ In. Sept. 1	Gravel ¾ In. One Year Ago	Sand Sept. 1	Sand One Year Ago
New York (*alongside dock*)	$1.75	$1.75	$1.75	$1.75	$1.00	$1.00
Denver	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	2.00*	1.60	2.00*	1.60	2.00*	1.40
St. Louis	1.45†	1.45†	1.45†	1.45†	1.20†	1.08†
Seattle	1.25	1.50	1.25	1.50	1.25	1.50
Dallas	2.38*	2.38*	2.38*	2.38*	2.00*	2.00*
Minneapolis	1.65‡	1.65‡	1.65‡	1.65‡	1.25	1.25
Cincinnati	1.30†	1.30†	1.30†	1.30†	1.05†	1.05†
San Francisco	1.80	1.80	1.80	1.80	1.40	1.40
Boston (*on trucks at dock*)	1.75†	1.50†	1.75†	1.50†	1.25†	1.00†
New Orleans	*1.95*†*	3.00†*	*1.95*†*	3.00†*	*1.40*†	1.80†
Los Angeles	2.00†*	1.15†	2.00†*	1.15†	1.40†	1.10†
Atlanta	3.30†	1.90†	3.30†	1.90†	1.75†	1.50†
Detroit	1.70	1.45	1.60	1.35	1.35	1.10
Baltimore	1.40	1.40	1.60	1.60	.70††	.70††
Montreal	1.90†	1.25†	*1.50*	1.50†	1.35†	1.25†
Birmingham	2.00*	2.00*	2.00*	2.00*	1.50	1.45
Philadelphia	2.25*	2.10*	2.25*	2.10*	1.65	1.50
Kansas City, Mo.	.....	.....	.....	.....	.66††	.66††
Pittsburgh	.....	.....	.85‡	.....	1.25	.....

*Delivered †Per ton.

CRUSHED STONE—Price for cargo or carload lots, per cu.yd., f.o.b. city, as follows:

	1½ In. Sept. 1	1½ In. One Year Ago	¾ In. Sept. 1	¾ In. One Year Ago
New York	$1.75	$1.75	$1.85	$1.85
Chicago	2.00†	1.70	2.00†	1.87½
St. Louis	1.83*	1.83*	1.83†	1.83*
Dallas	2.40†	2.40†	2.83†	2.83†
San Francisco	1.70	1.70	1.70	1.70
Boston (*on trucks at dock*)	2.00*	1.60*	2.00*	1.65*
Minneapolis	1.75	1.75	1.75	1.75
Kansas City	2.00	2.00	2.00	2.00
Denver	2.50†	2.50†	2.50†	2.50†
Seattle	3.00†	3.00†	3.00†	3.00†
Atlanta	3.75*†	2.50*†	3.75*†	2.50*†
Cincinnati	1.65*	1.65*	1.65*	1.65*
Los Angeles	2.00*†	1.40*	2.00*†	1.40*
Detroit	2.60*†	1.85*†	2.60*†	1.85*†
Baltimore	2.50†	2.50†	2.55†	2.55†
Montreal	1.80*	1.80*	2.00*†	2.00*
Philadelphia	2.25†	2.10†	2.25†	2.10†
Pittsburgh	2.75†	2.85†	2.75†	2.85†
Cleveland	2.70*†	2.70*†	2.70*†	2.70*†
Birmingham	2.00†	2.00†	2.00†	2.00†

*Per ton. †Delivered.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Buffalo District	1.25	1.35	2.25	1.25
Birmingham, Ala.	.90	1.25	2.05	.80
Cleveland, Ohio	1.20	1.20	.....	1.30*
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25

*Includes freight charge.

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
New York	$18.20	*$9.75*	$3.50*	$2.10@*2.35**
Chicago	20.00	18.00	.....	1.50†
St. Louis	23.50	17.50	.....	2.03*
Boston	18.20	11.00	3.50*	2.10@3.00*
Dallas	19.00	.....	.....	1.82†
Cincinnati	16.80	11.90	.....	11.40‡
San Francisco	27.50	24.00	.....	1.70†
Minneapolis	25.50	21.00	.....	1.70†
Denver	24.00	.....	.....	2.70*
Detroit	15.50	11.50	.....	12.00‡
Seattle, *paper sacks*	24.00	.....	2.80†	.....
Los Angeles	26.00	18.00	2.40†	14.00‡
Baltimore	24.25	17.85	2.55	.....
Montreal	.....	21.00	.....	10.00‡
Atlanta	24.50	13.50	1.35	1.50†
New Orleans	24.00	17.00	*2.25*†	2.00†
Philadelphia	23.00	15.00	.....	.....
Kansas City	19.00	14.00	2.75†	2.50*
Birmingham	22.50	16.00	2.40†	1.85†

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡ Per ton.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, exclusive of bags:

	Aug. 4	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.35	1.45
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	2.00	2.60
St. Louis (Carney)	2.85	2.35
Birmingham (Magnolia) pozzolan cement	2.40	2.40

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Sept. 1	One Month Ago	One Year Ago
New York, del. by truck	$2.35	$2.35@$2.50	$2.50@$2.60
New York, alongside dock to dealers	2.03	2.03	2.15
Jersey City	2.13	2.13	2.33
Boston	2.05	2.05	2.30
Chicago	2.05	2.05	2.10
Pittsburgh	2.04	2.04	2.09
Cleveland	2.24	2.24	2.29
Detroit	2.20	2.15	2.15
Indianapolis	2.19	2.19	2.29
Milwaukee	2.20	2.20	2.25
Duluth	2.04	2.04	2.09
Peoria	2.22	2.22	2.27
Cedar Rapids	2.24	2.24	2.34
Davenport	2.24	2.24	2.29
St. Louis	2.05	2.05	2.20
San Francisco	2.51	2.51	2.31
New Orleans	*1.97*	2.50	2.30
Minneapolis	2.22	2.22	2.32
Denver	2.85	2.85	2.85
Seattle	2.65	2.65	2.65
Dallas	2.05	2.05	2.05
Atlanta	2.40	2.40	2.35
Cincinnati	2.36	2.32	2.37
Los Angeles	2.56	2.56	2.36
Baltimore	2.50	2.50	2.50
Birmingham	2.40	2.40	2.40
Kansas City, Mo.	2.07	2.07	2.35
Montreal	2.22	2.22	1.15
Philadelphia	2.40	2.40	2.41
St. Paul	2.22	2.22	2.32
Toledo	2.20	2.20	2.20

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl. Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind	$1.80	Hudson, N. Y.	$1.75
Universal, Pa	1.80	Leeds, Ala	1.65
Steelton, Minn	1.85	Hannibal, Mo	1.90
Fordwick, Va	2.05	Lehigh Valley District	1.75
Mitchell, Ind	1.90	Wyandotte, Mich	1.90
Iola, Kan	1.85	Alpena, Mich	1.75
Mason City, Ia	1.80	Kingsport, Tenn	2.05
La Salle, Ill	1.90		

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carload lots at mills; from warehouse in less-than-carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0.99	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.26	1.29	1.76	1.35	1.38	1.55
068	35	1.54	1.58	2.16	1.66	1.67	1.91
093	45	1.98	2.03	2.77	2.13	2.00	2.46
126	57	2.45	2.51	3.45	2.63	2.55	3.03
153	68	2.92	2.99	4.11	3.14	3.15	.....
180	78	3.35	3.43	5.70	3.60	3.47	.....
245	103	4.43	4.53	6.21	4.75	4.58	.....
287	119	5.12	5.24	7.19	5.50	5.26	6.35
336	138	5.93	6.07	8.35	6.37	6.11	.....
395	160	6.88	7.04	9.65	7.38	7.12	.....
			PAVING				
036P	17	$0.76	$0.77	$1.06	$0.81	$0.76	.....
053P	24	1.07	1.09	1.50	1.14	1.07	.....
072P	31	1.35	1.38	1.90	1.45	1.39	.....
097P	40	1.74	1.78	2.45	1.87	1.90	.....
049R	24	1.07	1.09	....	1.14	1.02	.....
067R	31	1.35	1.38	....	1.45	1.39	.....
089R	40	1.74	1.78	....	1.87	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouse, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Prices in less-than-carload lots per 100 yd. for painted:

Weight in pounds	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$17.50	$19.50	$17.50	$16.50	$17.00	$24.00
2.5	18.50	21.50	18.50	17.50	19.00	26.00
3.0	21.00	24.50	21.00	20.00	22.00	29.00
3.4	22.50	27.50	22.50	21.50	24.00	31.00

BARS, CONCRETE REINFORCING—Current quotations per 100 lb., in carload lots, f.o.b., except at New York and St. Louis warehouses:

ROLLED FROM BILLETS

Inches	Pittsburgh	Birmingham	Warehouse: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$1.80@1.85	$2.00	$3.24	$2.15@$2.50	$3.15	$2.75	$2.95
⅝	1.90@1.95	2.10	3.34	2.40@2.60	3.25	2.85	3.05
¾	2.00@2.05	2.20	3.44	2.50@2.70	3.35	2.95	3.15
⅞	2.20@2.25	2.40	3.64	2.70@2.90	3.55	3.10	3.35
1	2.80@2.85	3.00	4.24	3.30@3.50	4.15	3.75	3.95

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923.

ROLLED FROM RAILS

	St. Louis	Dallas		St. Louis	Dallas
½ in and larger	$2.25	$2.48	⅝	$2.65	$2.88
¾	2.35	2.58	⅞	3.25	3.48
1	2.45	2.68			

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Sept. 1	One Month Ago	One Year Ago	Paving Brick: 3-inch*	3½-inch*
New York (del.)	$17.00	$17@19	$20.40@22.40	$45.00†	$51.00†
New York (at dock)	13.00	14@16	17.00		
Chicago	12.00	12.00	12.00	42.00	45.00
St. Louis, salmon (del.)	15.00	15.00	16.00	40.00	42.50
Denver, salmon	8@12	9@10	9@10	.....	.....
Dallas	13.60	13.60	14.10	35.00	.....
San Francisco	14.00	14.00	15.00	.....	.....
Los Angeles	10.00	10.00	10.00	(not used)	
Boston (del.)	*18.50*	20.00	19.00	45.00	50.00
Minneapolis (del.)	13.75	13.75	13.75	.....	.....
Kansas City	12.50	14.00	14.00	(no market)	
Seattle	14.00	14.00	15.00	.....	55.00
Cincinnati	15.50	15.50	15.50	40.00	45.00
Montreal	20.25	20.25	20.25	100.00‡	.....
Detroit (del.)	16.00	14.00	14.00	*35.25*	*38.50*
Baltimore	18.00	18.00	18.00	40.00	45.00
Atlanta	12.50	12.50	10.50	40.00	.....
New Orleans	*13.00*	15.00	15.00	60.00	75.00
Birmingham	14.50	14.50	14.50	40.00	45.00
Philadelphia	18.00	18.00	19.00	40.00	50.00
Pittsburgh (del.)	17.00	17.00	16.00	.....	.....
Cleveland	14@16	14@16	12@14	.....	.....

*For paving blocks 3x8½x4 and 3½x8½x4 respectively. †In cars. ‡Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Sept. 1 on Trucks*†	One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco†	Perth Amboy N. J., Factory*
4x12x12	$0.1027	$0.1112	$0.076	$0.105	$0.068	$0.108	.....
6x12x12	.1541	.1667	.104	.....	.09	.156	.....
8x12x12	.1926	.2084	.142	.21	.126	.244	.....
10x12x12	.....	....	.182	....	.158	.....	$0.2388
12x12x12	.....	....	.202	.32	.186	.....	.2956

*5 per cent off for cash. †Partition tile.

	4x12x12	8x12x12	12x12x12
Boston	$0.08	$0.145	$0.245
Minneapolis (f.o.b. cars)	.072	*.125*	.225
Cincinnati	.064	.1295	.1726
Kansas City	.088	.158	.242
Denver	.085	.155	.22
Seattle	.10	.18	.26
Los Angeles	.085	.172	.285
New Orleans	*.0808*	*.1516*	*.2232*
Detroit	.0707	.1326	.1853
Montreal	.10	....	.....
Baltimore	.124	.268	.....
Atlanta	.0724	.1358	.....
Dallas	.103	.19	.31
Birmingham	.11	.124	.255
Pittsburgh	.068	.128	.179
Cleveland	.07	.12	.....

STRUCTURAL MATERIAL—Following are base prices per 100 lb in carload lots, f.o.b. mill, Pittsburgh and Birmingham, together with quotations in less-than-carload lots from warehouses at places named:

	Pittsburgh	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.80@1.85	$2.05	$3.34	$4.10	$3.25	$3.10	$3.10
Channels, 3 to 15 in.	1.80@1.85	2.05	3.34	4.10	3.25	3.10	3.10
Angles, 3 to 16 in., ¼ in. thick	1.80@1.85	2.05	3.34	4.10	3.25	3.10	3.10
Tees, 3 in. and larger	1.80@1.85	2.05	3.34	4.10	3.35	3.10	3.10
Plates, ¼ in. thick and heavier	1.80@1.85	1.95	3.34	4.10	3.25	3.10	3.10

RIVETS—The following quotations are per 100 lb.:.

STRUCTURAL

	Pittsburgh Mill	New York: Sept. 1	New York: One Yr. Ago	Warehouse: Chicago	St. Louis	San Francisco	Dallas
½ in.	$2.75@$3.00	$5.00	$4.20	$3.60	$3.75	$5.50	$4.75
			CONE HEAD BOILER				
½ in.	$3.10@$3.35	....	$4.40	$3.60	$3.90	$5.50	$5.00
⅝ and ¾	3.25@ 3.50	....	4.55	*3.70*	3.90@4.15	5.65	5.15
⅞ and 1	3.50@ *3.60*	....	4.80	*3.95*	*4.10*	5.85	5.50

NAILS—The following quotations are per 100 lb. keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.55	$2.85	$2.95	*$3.25*	$4.25	$2.83	$4.95
Cut	2.80	2.90	....	5.00	5.00	2.95	5.00

SHIP SPIKES—Current prices per 100 lb.:

In	San Francisco: Galv.	San Francisco: Black	Seattle Black
½	$7.50	$5.75	$7.75
⅝	7.05	5.30	5.65
¾	6.90	5.15	5.50

Pittsburgh base in lots of 200 kegs or more, $3.50.

PREPARED ROOFINGS—Slate-surfaced roofing in rolls weighing 85 to 90 lb. costs $1.93½ per square to contractors in carload lots f.o.b. New York.

Single shingles, slate finish, cost $5.62½ per square (sufficient to cover 100 sq.ft.) in carload lots, f.o.b. New York. Strip shingles (4 in 1) f.o.b. New York, in carload lots to contractors, $4.27½ per square for the hexagonal shape, with Underwriters' label.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carload lots:

Tarred felt per 100 lb	$2.94½
Asphalt coating, per gal	31½
Asphalt felt, per 100 lb	3.09

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 83 per cent; "A," 88 per cent; "B," 89 per cent. Double thickness "AA," 83 per cent; "A," 88 per cent; "B," 89 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.25	$3.60	$3.50	$3.85	$3.89
No. 12	2.30	3.65	3.55	3.90	3.94
No. 14	2.35	3.70	3.60	3.95	3.99
No. 16	2.45	3.80	3.70	4.05	4.09
Black					
Nos. 18 to 20	2.80	4.25	3.75	4.70	4.00
No. 22	2.95	4.40	3.90	4.85	4.15
No. 24	3.00@3.10	4.45	3.95	4.90	4.20
No. 26	3.10	4.55	4.05	5.00	4.30
No. 28	3.25	4.70	4.20	5.15	4.45
Galvanized					
No. 10	3.15	4.55	4.10	4.75	4.25
Nos. 12 to 14	3.25	4.65	4.20	4.85	4.35
No. 16	3.35	4.75	4.30	4.95	4.45
No. 18	3.50	4.90	4.45	5.10	4.60
No. 20	3.65	5.05	4.60	5.25	4.75
No. 22	3.70	5.10	4.65	5.30	4.80
No. 24	3.85	5.25	4.80	5.45	4.95
No. 26	4.05	5.50	5.05	5.70	5.20
No. 28	4.30	5.75	5.30	5.95	5.45

For galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per 7½-lb. gallon for raw oil:

	New York: Sept. 1	New York: One Year Ago	Chicago: Sep. 1	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	$.86½	$0.95½	$0.83½	$0.92

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Sept. 1	1 Yr. Ago	Sept. 1	1 Yr. Ago
Red	$13.75	$15.25	$15.25	$16.75
White	13.75	15.25	13.75	15.25

Lumber

Prices wholesale, per M. ft. b.m., in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to contractors at yards.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$26.00	$27.00	$28.00	$31.00
3x6 and 8	26.00	27.00	28.00	31.00
4x4-6 and 8	26.00	27.00	28.00	31.00
3x10 and 12	26.00	27.00	28.00	31.00
3x14	30.00	30.00	32.00	34.00
4x10 and 12	26.00	27.00	28.00	31.00
4x14	30.00	30.00	32.00	34.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$28.00	$30.00	$32.00
6x14	34.00	36.00	38.00
8x10	28.00	30.00	32.00
8x14	34.00	36.00	38.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York		Chicago	
	20 Ft. and Under L.L.Y.P.	22-24 Ft. L.L.Y.P.	20 Ft. and Under No.1 L.L.Y.P.	Up to 32 Ft. No.1 Douglas Fir
3x4 to 8x8	$43.00	$44.00	$38.00	*$38.50*
3x10 to 10x10	50.00	51.00	45.00	*38.50*
3x12 to 12x12	57.00	58.00	54.00	*38.50*
3x14 to 14x14	65.00	66.00	...	*38.50*
3x16 to 16x16	77.00	78.00	...	*40.00*

New York—Wholesale price of long-leaf yellow pine timbers (rough) to dealers; to contractors, delivered from lighters to job, $5@$10 additional. Short-leaf pine costs $3 per M. ft. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. and $1 for each additional foot from 32 to 36 ft.

Other Cities

	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	$47.75	$47.50†	$49.00	$52.00	*$57.50*	*$57.00*†
Seattle	.....	24.00	.....	.....	.....	23.00
New Orleans	36.00	.....	.....	.....	43.00	.....
Baltimore	35.00	49.25	53.00	60.00	65.00	49.75
Cincinnati	37.00	73.00	73.00	85.00	48.00	77.00
Montreal	50.00	55.00	.....	.....	60.00	50.00
Los Angeles	.....	32.00	.....	.....	.....	32.00
Denver	.....	33.25	34.25	34.25	.....	34.25
Minneapolis	42.50	38.75	34.50	.....	47.00	39.75
Atlanta	31.00	.....	.....	.....	34.00	.....
Dallas	56.00	.....	.....	.....	56.00	.....
Kansas City, Mo.	41.50	39.75	.....	.....	55.50	40.25
Birmingham	32.00	.....	.....	.....	34.00	.....
Philadelphia	48.00	36.00	38.00	45.00	62.00	76.00
Detroit	44.00	41.50	.....	.....	55.00	41.50
St. Louis	39.00	.....	.....	.....	51.00	.....

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	$43.50	$43.00†	*$44.50*	$48.50	$48.00†
Seattle	.....	22.00	.....	.....	23.50
New Orleans	38.00	46.00	.....	28.00	34.00
Baltimore	55.00	44.00	44.00	34.00	*49.50*
Cincinnati	70.00	79.00	75.00	38.00	85.00
Montreal	45.00	55.00	40.00	65.00	50.00
Los Angeles	.....	24.50	.....	.....	36.00
Denver	.....	32.75	33.25	.....	32.25
Minneapolis	40.50	36.25	34.75	35.50	35.00
Atlanta	22.00	.....	.....	28.00	.....
Dallas	52.25	.....	.....	56.00	.....
Kansas City, Mo.	49.25	39.75	.....	40.00	34.25
Birmingham	27.00	.....	.....	45.00	.....
Philadelphia	30.00	36.00	36.00	52.00	36.00
Detroit	40.50	37.00	.....	44.00	41.25
St. Louis	38.00	.....	.....	28.00	.....

*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Sept. 1	One Month Ago	One Year Ago
$2.20@$2.25	$2.20@$2.25	$2.25@$2.30

CONCRETE BLOCKS—Standard 8x8x16-in., delivered to job, each:

Denver	$0.22	St. Louis	$0.20
Detroit	.16	Boston	.18@.20
New Orleans	....	Minneapolis	.14*
Brooklyn and Queens	.18@.20	Philadelphia	.18@.20
Pittsburgh	.16@.18	*F.o.b.	

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ½-in., 8 ft.; ⅝-in., 6; ¾-in., 4½; 1-in., 3½; 1¼-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following are prices per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	$0.24	New Orleans	$0.21
New York	.25	Los Angeles	.25
Chicago	.23	Seattle	.23
Minneapolis	.25	St. Louis	.22½
San Francisco	.22½	Montreal	.17
Atlanta	.27	Detroit	.24½
Denver	.25@.26	Baltimore	.18
Cincinnati	.21	Kansas City	.25
Dallas	.31	Birmingham	.26@.27
Philadelphia	.24		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.265*	$0.2875*
Boston	.235	.265
Kansas City	.2225	.2475
Seattle	.165	.19
Chicago	.195†	.2175†
Minneapolis	.1917	.2123
St. Louis	.22	.24½
Denver	.2025	.2275
Dallas	.225	.306
Los Angeles	.1875	.2225
Atlanta	.23	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.1675	.1895
Birmingham	.22	.24
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

*Special gelatin in case lots. †Quantities above 500 lb. and less than a ton

CHEMICALS—Water and sewage treatment chemicals, carload lots at New York:

Sulphate of aluminum, in bags, per 100 lb	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb	4.90@5.00
Soda ash, 58%, in bags, per 100 lb	1.32½@1.37½
Chlorine, liquid, cylinders, per lb	.05½@.08
Hypochlorite of lime (bleaching powder) in drums, per 100 lb	2.00@2.10*

*F. O. B. Works.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.